July 16, 2003

Bruce Rodger
Wisconsin Department of Natural Resources
101 S. Webster Street
Madison, WI 53707-7921

Re: Mayville, Wisconsin Visibility Study
Annual Report for the Period January 1, 2002 – December 31, 2002

Dear Bruce:

Enclosed are two (2) copies of the annual report for the period January 1, 2002 – December 31, 2002, for the Mayville Visibility Study, covered under purchase orders NMB00000214 (7/01 – 6/02) and NMC00000227 (7/02 – 6/03). I have also enclosed a CD containing final validated files of hourly nephelometer data and a PDF copy of the report.

Please contact me if you have any questions regarding the report or require any additional information.

Sincerely,

Heather Wayne
Project Scientist

Enclosures

MAYVILLE WISCONSIN
VISIBILITY STUDY
ANNUAL REPORT

Prepared for

BRUCE RODGER
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
101 S. Webster Street
Madison, WI 53707

Prepared by

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July 16, 2003

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1.0 INTRODUCTION

This report describes the Mayville Wisconsin air quality, meteorological, and visibility monitoring work completed January 1, 2002 – December 31, 2002, by Air Resource Specialists, Inc. (ARS) and Wisconsin Department of Natural Resources (DNR), under purchase orders NMB00000214 (7/01 – 6/02) and NMC00000227 (7/02 – 6/03).

ARS was responsible for collecting nephelometer (particle scattering), ambient temperature, relative humidity, wind speed, and wind direction data, validating the nephelometer, ambient temperature and relative humidity data, and providing the validated nephelometer, ambient temperature and relative humidity data to the Cooperative Institute for Research in the Atmosphere (CIRA) for upload to the Interagency Monitoring of Protected Visual Environments (IMPROVE) web site[1]. Wisconsin DNR was responsible for collecting ozone, $PM_{2.5}$, ambient temperature, relative humidity, wind speed, wind direction, and solar radiation, validating all parameters, and uploading all parameters (with the exception of relative humidity) to the Environmental Protection Agency Air Quality System (EPA AQS) database. All work performed during the reporting period is described in this report and is organized into the following major sections:

Any questions or comments regarding this report should be addressed to:

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[1] http://vista.cira.colostate.edu/improve

2.0 SITE SPECIFICATIONS

The scope of the monitoring program includes the collection and reporting of optical, meteorological, and air quality data. All instrumentation was run on Central Standard Time (CST). Both ARS and Wisconsin DNR have data collection responsibilities at the Mayville, Wisconsin site. The nephelometer and relative humidity data presented in this report were collected and validated by ARS. The $PM_{2.5}$ TEOM, ozone, ambient temperature, wind speed, wind direction, and solar radiation data were collected and validated by Wisconsin DNR and represents the final data uploaded to the EPA AQS Database. Figure 2-1 presents a site location map.

A high resolution digital camera system is located at the Mayville site and operates as part of the MidWest haze camera network (MidWest hazecam)[2]. Archived images from this camera have been used in this report to represent conditions seen at the site.

Table 2-1 lists the parameters monitored and the equipment used at the Mayville, Wisconsin site, for the period January 1, 2002 – December 31, 2002. Wisconsin DNR personnel installed the Optec NGN-2 ambient nephelometer on November 28, 2000 and the Qualimetrics Novalynx model 240-150 solar radiation sensor on May 1, 2001. All other equipment was installed by Wisconsin DNR personnel prior to December 2000.

[2] http://www.mwhazecam.net/mayville.html

Table 2-1

Mayville, Wisconsin
Monitored Parameters and Equipment

Parameters	Manufacturer/Model	Collected by ARS	Collected by WISC. DNR	Operational Period
Particle Scattering	OPTEC NGN-2	X		1/01/2002 – 12/31/2002
Ozone	API 400A		X	1/01/2002 – 12/31/2002
PM2.5	Rupprecht & Patashnick 1400ab		X	1/01/2002 – 12/31/2002
Ambient Temperature	Rotronics MP101A	X	X	1/01/2002 – 12/31/2002
Relative Humidity	Rotronics MP101A	X	X	1/01/2002 – 12/31/2002
Wind Speed	Qualimetrics 2030	X	X	1/01/2002 – 12/31/2002
Wind Direction	Qualimetrics 2020	X	X	1/01/2002 – 12/31/2002
Solar Radiation	Qualimetrics 240-150		X	1/01/2002 – 12/31/2002
Digital Photography	ARS HRDC-R	X		1/01/2002 – 12/31/2002

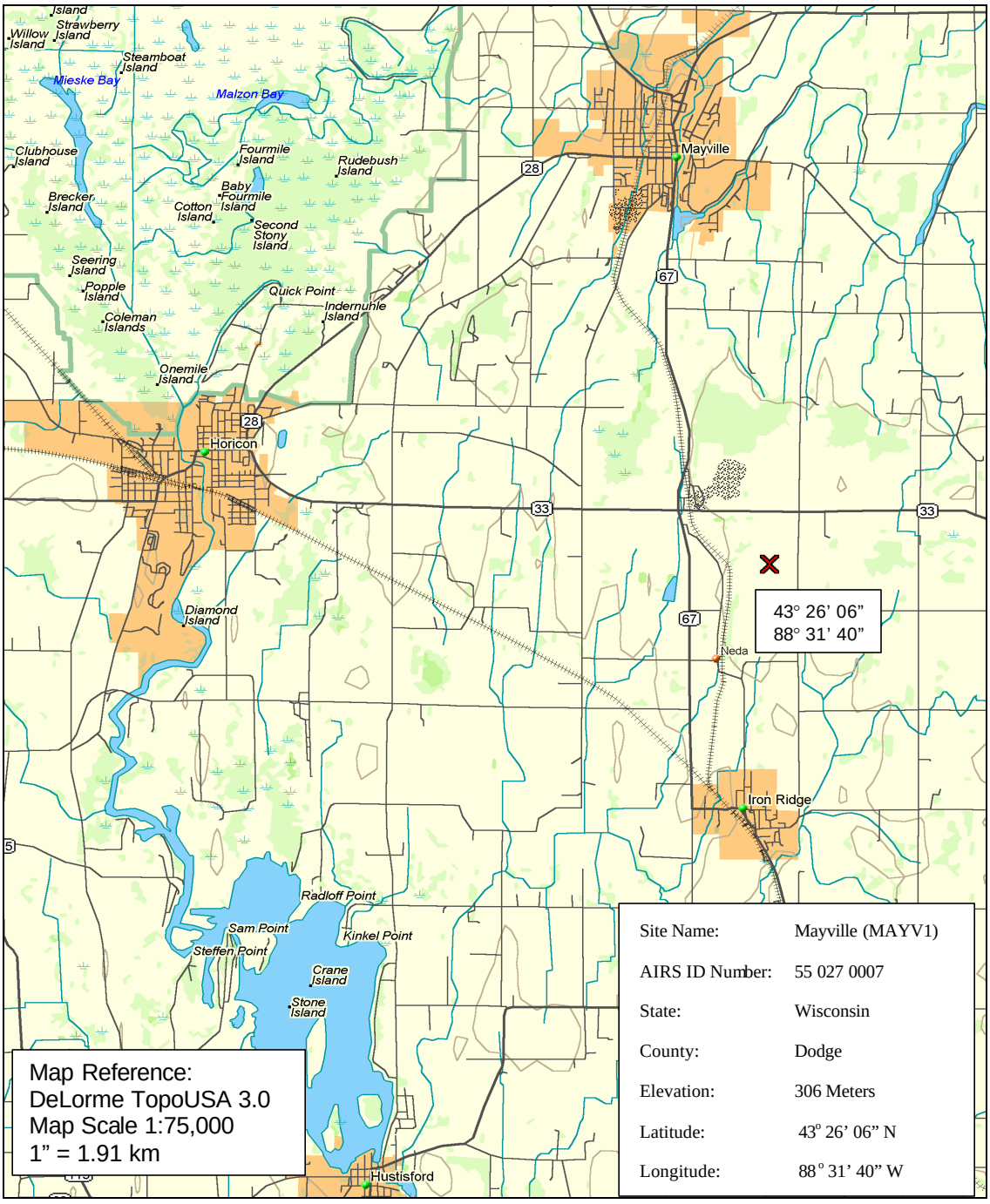


Figure 2-1. Mayville, Wisconsin, air quality monitoring location.

3.0 SUMMARY OF NEPHELOMETER MONITORING

An ambient nephelometer collected continuous measurements of the ambient atmospheric particle scattering coefficient (b_{sp}). An ambient temperature/relative humidity (AT/RH) sensor was collocated with the nephelometer for data validation and interpretation purposes. Data was collected with a datalogger and downloaded via telephone modem daily. The data were then validated in three stages according to IMPROVE protocol (Level-A, Level-0, and Level-1) as described below. Standard Operating Procedures (SOPs) and Technical Instructions (TIs) that fully describe the applied acquisition and reduction procedures include:

- SOP 4300 Collection of Optical Monitoring Data (IMPROVE Protocol)
- TI 4300-4002 Nephelometer Data Collection via Telephone Modem (IMPROVE Protocol)
- TI 4300-4006 Nephelometer Data Collection via Campbell Scientific Data Storage Module (IMPROVE Protocol)
- TI 4400-5010 Nephelometer Data Reduction and Validation (IMPROVE Protocol)

3.1 NEPHELOMETER MONITORING SYSTEM

The nephelometer system was configured with the following instrumentation:

- Optec NGN-2 Ambient Nephelometer
- Rotronic MP-101A Air Temperature/Relative Humidity (AT/RH) sensor with passive air radiation shield
- Serial/Analog Data Acquisition System, including:
  - Campbell Scientific CR10 datalogger
  - Serial data interface
  - Solid state storage module (SM 192)
- Manual span gas system (SUVA 134a span gas, gas regulator, and supply hoses)
- Mounting tower and hardware

Sensor and sampling specifications are summarized in Table 3-1.

Table 3-1

NGN-2 Ambient Nephelometer and AT/RH Sensor
Station Sensor and Sampling Specifications
Mayville, Wisconsin

Parameter	Sensor	Units	Sample Frequency	Notes
Nephelometer Raw readings	Optec NGN-2 Nephelometer	mVDC and Counts	2-minute average samples every 5 minutes	Optec NGN-2 Serial Output Logged
Nephelometer clean air calibration readings	Optec NGN-2 Nephelometer	mVDC and Counts	10-minute average at approximately 6-hour intervals	Start time drifts as controlled by Optec NGN-2 software
Nephelometer span calibrations (SUVA 134a)	Optec NGN-2 Nephelometer	mVDC and Counts	10-minute average performed manually at approximately 7-14 day intervals	Operator initiated during site visits
Nephelometer operating mode code	Optec NGN-2 Nephelometer	Unit less	1 code per nephelometer raw reading	Optec NGN-2 Serial Output Logged
Chamber temperature	Solid State Sensor	C	Concurrent with nephelometer reading	Available on serial data stream only
Ambient temperature	Rotronic MP-101A solid-state AT/RH	C (-30 to +50C)	Concurrent with nephelometer reading (5-minute averages of 10-second samples)	Sensor in passive air radiation shield
Ambient relative humidity	Rotronic MP-101A solid-state AT/RH	%RH (0 to 100%)	Concurrent with nephelometer reading (5-minute averages of 10-second samples)	Sensor in passive air radiation shield

3.2 ON-SITE DATALOGGING

The CR10 datalogger collected and time-tagged the following data:

- Nephelometer RS232 serial data, including:
  - Status (ambient, clean air, span, lamp out, rain, chopper failure)
  - Raw scattered light value (counts)
  - Raw lamp brightness value (counts)
  - Normalized scattered light value (counts)
  - Integration time (minutes)
  - Chamber temperature (C)
  - Date: year - month - day (over range on the CR10)
  - Time: hour - minute (CST)

- Nephelometer analog data, including:
  - Analog line 1: normalized scattered light value (mV)
  - Analog line 2: status (mV)

- Ambient temperature (°C) - 5-minute averages of ten-second samples

- Relative humidity (%) - 5-minute averages of ten-second samples

The nephelometer was operated on Central Standard Time in a 5-minute cycled mode, as described in Table 3-1. Clean air calibrations were automatically performed at approximately 6-hour intervals. Manual clean air and span gas calibrations were performed at approximately 7-14 day intervals.

3.3 NEPHELOMETER DATA COLLECTION AND VALIDATION

The three levels of IMPROVE protocol data validation are described in the following subsections.

3.3.1 Level-A Nephelometer Data Validation

Raw nephelometer data collected daily from the site were reformatted and undergo Level-A validation. The procedures include:

- Nephelometer, ambient temperature, and relative humidity data are extracted from the raw data and appended to site-specific Level-A validated data files. Nephelometer and datalogger-generated status codes are appended along with the data. Data too large or too small to occupy the data fields in the Level-A data files are set to -99.

- Zero and span calibrations recorded by the datalogger are extracted from the raw data and entered into the QA calibration database. Calibration information is used during Level-1 validation.

Data at this point are at Level-A validation. Level-A data are visually reviewed daily to identify operational problems and initiate corrective procedures as soon as possible. Level-A validated data are plotted weekly, and comments regarding the operation of the nephelometer are noted on the plots. Data from operator log sheets are checked against data collected via telephone modem to identify inconsistencies and errors. Data from the log sheets are entered into the Quality Assurance (QA) Database.

3.3.2 Level-0 Nephelometer Data Validation

Level-0 validation of nephelometer data was performed after all study data were collected. During Level-0 validation ARS staff scientists review Level-A data to identify periods of invalid data caused by the following:

- Burned out lamp
- Power failures
- Water contamination in nephelometer chamber
- Meteorological sensor failures (out of range values)
- Other problems

Periods identified as invalid are entered into the QA database.

3.3.3 Level-1 Nephelometer Data Validation

Level-1 validation of nephelometer data are generated from Level-0 data, and includes:

- Conversion of raw nephelometer and meteorological data to engineering units
- Checks for out of range values
- Identification of nephelometer b_{sp} data affected by meteorology
- Estimation of uncertainty

Each of these steps is detailed below:

Conversion of Raw Nephelometer and Meteorological Data to Engineering Units

- Meteorological data (ambient temperature, relative humidity, and chamber temperature) are already in engineering units.

- The nephelometer scattering coefficient (b_{sp}) is calculated by determining a calibration line for each data point, based on the interpolated current zero value and the difference between the original span and zero.

Level-1 Range Checks

Level-1 5-minute and hourly average data are checked as follows:

- Data invalid at Level-0 is invalid at Level-1
- Calculated b_{scat} data (b_{sp} plus Rayleigh scattering) less than 80% Rayleigh scattering are invalid at Level-1 (Rayleigh scattering of 11.064 Mm^{-1}, based on elevation, was used at the Mayville site.)
- Meteorological data valid at Level-0 are valid at Level-1

Identification of Nephelometer b_{sp} Data Affected by Meteorology

Nephelometer measurements can be greatly influenced during periods of:

- Fog
- Heavy rain
- High relative humidity (> 90%)
- Blowing snow
- Other extreme meteorological conditions

Under these conditions nephelometer readings will no longer correspond to the optical properties of particulates in the atmosphere. Periods of meteorological interference identified during Level-1 are labeled "Weather Affected". Data not so labeled are called "Filtered". The following filters were used to identify these periods:

- Maximum: hourly b_{sp} data exceeding 5000Mm^{-1} was coded as weather-affected.
- Relative Humidity: hourly b_{sp} data when the relative humidity exceeded 90% was coded as weather-affected.
- Rate of change: hourly b_{sp} data when the rate of change between consecutive hourly scattering values exceeded 50 Mm^{-1}, both values were coded as weather-affected.
- Standard deviation divided by the mean: hourly b_{sp} data when the standard deviation divided by the mean of the valid 5-minute scattering readings exceeded 10% was coded as weather-affected.

Figure 3-1 is a format key that summarizes a Level-1 validated nephelometer data file.

```
ARSDATA V5.0j: 08/03/2000 09-01-2000 05:09:36----------------------------------------------------------------------------------------------------------------------------------------------------------------
LEVEL-0: 04-13-2001 17:22:42 NGN_SEAS V6.0 04/09/2001 EXE DATE:04/10/2001 10:51----------------------------------------------------------------------------------------------------------------------------------------
LEVEL-0: INPUT FILE: c:\Neph_Reprocessing\Level_A\More_Level_A\GRSM1_N.003 09/12/2000 21:19----------------------------------------------------------------------------------------------------------
LEVEL-1: 04-13-2001 17:25:32 NGN_SEAS V6.0 04/09/2001 EXE DATE:04/10/2001 10:51----------------------------------------------------------------------------------------------------------------------------------------
LEVEL-1: Rayleigh= 10.636 Span Mult= 7.1 QA Search Flags:1 1----------------------------------------------------------------------------------------------------------------------------------------------------
LEVEL-1: NEPHCOMMON LIBRARY VERSION:04/09/2001----------------------------------------------------------------------------------------------------------------------------------------------------------
LEVEL-1: INPUT FILE: c:\Neph_Reprocessing\Level_0\FINAL_LEVEL_0\More_FINAL_LEVEL_0\GRSM1_N0.003 04/13/2001 17:25----------------------------------------------------------------------------------------
```

SITE	YEARMMDD	JD	HHMM	INS	BSP	PREC	V	A	RAW-M	RAW-SD	#	N/A	SD/M	DEL	MAX	RH	0123456789mPM0T	YINTER	SLOPE	AT	AT-SD	#	AT-PR	CT	CT-SD	#	CT-PR	RH	RH-SD	#	RH-PR	N/A
GRSM1	20000601	153	0000	025	58	0.150	0		238.84	7.10	11	-99.0	10.0	50	5000	90	0B1000000000012	-154.0	0.93	20.18	0.35	12	1.00	20.15	0.32	10	1.00	75.35	1.99	12	2.00	XXXX
GRSM1	20000601	153	0100	025	64	0.150	0		245.45	3.36	11	-99.0	10.0	50	5000	90	0B1000000000011	-154.7	0.93	19.59	0.25	12	1.00	19.81	0.26	11	1.00	78.02	1.29	12	2.00	XXXX
GRSM1	20000601	153	0200	025	58	0.150	0		239.87	5.27	12	-99.0	10.0	50	5000	90	0C0000000000000	-154.9	0.93	19.58	0.37	12	1.00	19.59	0.25	12	1.00	77.39	2.31	12	2.00	XXXX
GRSM1	20000601	153	0300	025	59	0.150	0		240.88	11.88	12	-99.0	10.0	50	5000	90	0C0000000000000	-155.2	0.93	19.44	0.65	12	1.00	19.73	0.43	12	1.00	78.33	4.10	12	2.00	XXXX
GRSM1	20000601	153	0400	025	55	0.150	0		236.96	7.97	12	-99.0	10.0	50	5000	90	0C0000000000000	-155.4	0.93	19.16	0.38	12	1.00	19.20	0.26	12	1.00	78.90	2.43	12	2.00	XXXX
GRSM1	20000601	153	0500	025	54	0.150	0		235.65	1.57	12	-99.0	10.0	50	5000	90	0C0000000000000	-155.7	0.93	19.42	0.10	12	1.00	19.47	0.08	12	1.00	77.63	0.47	12	2.00	XXXX
GRSM1	20000601	153	0600	025	53	0.150	0		235.24	3.15	12	-99.0	10.0	50	5000	90	0C0000000000000	-155.9	0.93	19.96	0.37	12	1.00	20.28	0.49	12	1.00	76.43	1.02	12	2.00	XXXX
GRSM1	20000601	153	0700	025	53	0.150	0		235.33	2.39	10	-99.0	10.0	50	5000	90	0A2000000000023	-156.1	0.93	21.56	0.52	12	1.00	21.88	0.35	9	1.00	72.19	0.91	12	2.00	XXXX
GRSM1	20000601	153	0800	025	54	0.150	0		236.68	3.25	12	-99.0	10.0	50	5000	90	0C0000000000000	-156.0	0.93	22.36	0.18	12	1.00	22.14	0.08	12	1.00	71.68	0.96	12	2.00	XXXX
GRSM1	20000601	153	0900	025	53	0.150	0		234.82	6.44	12	-99.0	10.0	50	5000	90	0C0000000000000	-155.7	0.93	22.73	0.40	12	1.00	22.16	0.22	12	1.00	72.21	2.60	12	2.00	XXXX

Field	Description
SITE	Site Abbreviation
YYYYMMDD	Date (4-digit year/month/day)
JD	Julian Date
HHMM	Time using a 24-hour clock in hour/minute format
INS	Nephelometer Serial Number
BSP	b_{sp} (Mm^{-1})
PREC	b_{sp} Estimated Precision (%/100)
V	b_{sp} Validity Code (0 = valid, 1 = interference, 2 = invalid, 9 = suspect)
A	b_{sp} Interference Code[1]
RAW-M	Raw Nephelometer Hourly Average (Counts)
RAW-SD	Standard Deviation of Raw Nephelometer Average (Counts)
#	Number of Data Points in Hourly Nephelometer Average
N/A	(Not Used)
SD/M	Standard Deviation/Mean Interference Threshold
DEL	b_{sp} Rate of Change Interference Threshold
MAX	Maximum b_{sp} Interference Threshold
RH	Relative Humidity Interference Threshold
0123456789mPMOT	Composite Nephelometer Code Summary[2]
YINTER	Y-intercept of Calibration Line Used to Calculate b_{sp}
SLOPE	Slope of Calibration Line Used to Calculate b_{sp}
AT	Average Ambient Temperature (°C)
AT-SD	Standard Deviation of Hourly AT Average
#	Number of Data Points in Hourly AT Average
AT-PR	Estimated Precision of Ambient Temperature
CT	Average Nephelometer Chamber Temperature (°C)
CD-SD	Standard Deviation of Hourly CT Average
#	Number of Data Points in Hourly CT Average
CT-PR	Estimated Precision of Chamber Temperature
RH	Average Relative Humidity (%)
RH-SD	Standard Deviation of Hourly RH Average
#	Number of Data Points in Hourly RH Average
RH-PR	Estimated Precision of Relative Humidity
N/A	(Not Used)

[1] b_{sp} Interference Code:

Condition	Letter Code														
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
RH > RH threshold	x		x		x		x		x		x		x		x
b_{sp} > maximum b_{sp} threshold	x	x			x	x			x	x			x	x	
SD/M > uncertainty threshold			x	x	x	x					x	x	x	x	
$\triangle b_{sp}$ > delta threshold								x	x	x	x	x	x	x	x

Z Weather observation between two other weather observations.

Threshold values may be different for each site.

[2] Composite Nephelometer Code Summary:

0123456789	Nephelometer diagnostic code (internal use)
m	Number of missing data points
P	Number of power failure codes
M	Number of manual QA invalidation codes
O	Number of Level-0 invalidated data points
T	Number of times non-serial data were used

Figure 3-1. Level-1 Validated Nephelometer Data File Format Key.

Nephelometer Measurement Uncertainty

The measurement uncertainty of the Optec NGN-2 ambient nephelometer is calculated from the distribution of calibration slopes determined during manual span/zero calibrations. The reported uncertainty is the 95% confidence limit of a two-tailed t-distribution.

Important elements of Optec NGN-2 nephelometer calibration are:

- The nephelometer output consists of unit less values (counts).
- The nephelometer has no adjustable parameters.
- The unit less clean air (zero) and SUVA 134a (span) calibration values correspond to nephelometer-detector response to scattering by Rayleigh air and SUVA 134a, respectively.
- After a period of time, the nephelometer chamber will tend to accumulate dust and other matter, increasing the background scattering. The value (in counts) of clean air and SUVA 134a calibrations, therefore, will increase over time.
- Rayleigh scattering of air is a function of temperature and pressure, but can be reasonable approximated based on site altitude.
- The scattering for SUVA 134a is assumed to be equal to 7.1 times that of Rayleigh air.

The overall uncertainty for the nephelometer from 11/14/2001 through 10/31/2002 was 14.5%. The nephelometer was removed for servicing on 10/31/2002 and reinstalled on 11/13/2002. The uncertainty for the nephelometer from 11/13/2002 through 12/31/2002 was 15.6%.

Air Temperature/Relative Humidity Sensor Uncertainty

The AT/RH sensor collocated with the nephelometer was calibrated prior to installation and shown to perform within the manufacturer's specifications upon installation. The AT/RH sensor was audited in late March and early April with an 80% NIST Standard, the station RH reading was found to be higher than expected. The March 27th and April 10th audit results can be found in Appendix F. The AT/RH sensor was replaced on April 10th.

4.0 DATA SUMMARIES AND STATISTICS

4.1 DATA DELIVERABLES

A CD containing final validated files of hourly nephelometer data are delivered with this report.

4.2 DATA RECOVERY STATISTICS

Data validation statistics for the monitoring period are summarized by parameter in Table 4-1. Missing/Invalid data codes were not provided when the data was uploaded from Wisconsin DNR files to the EPA AQS database. Therefore, data collection statistics are not provided in this report.

Table 4-1

Data Validation Statistics
Mayville, Wisconsin
January 1, 2002 – December 31, 2002

Parameter	Interval	No. Possible	No. Valid	% Valid
Ozone	hourly	8760	8596	98.1
PM2.5 TEOM	hourly	8760	8099	92.5
Relative Humidity	hourly	8760	8404	95.9
Solar Radiation	hourly	8760	8626	98.5
Scalar Wind Direction	hourly	8760	8628	98.5
Scalar Wind Speed	hourly	8760	8628	98.5
Ambient Temperature	hourly	8760	8317	94.9
Nephelometer b_{sp}	hourly	8760	5594*	63.9*

*No. and % Valid are equal to the number and percent of filtered data.

4.3 METEOROLOGICAL SUMMARY STATISTICS

Meteorological summary statistics for the reporting period are summarized by parameter in Appendix A.

Wind roses for the reporting period can also be found in Appendix A. Note that the wind roses in this report vary slightly from the wind roses that were presented in the Mayville Visibility Study preliminary reports. This variation is due to differing data validation techniques between ARS and Wisconsin DNR. Wisconsin DNR data validation protocol is, if the winds speed falls below 3mph the wind speed and wind direction are set equal to 0 to denote calm conditions.

4.4 TIMELINE OF AIR QUALITY AND METEOROLOGICAL DATA

Timeline plots of final validated air quality and meteorological data are provided in Appendix B. Note that the particle scattering (b_{sp}) that is plotted in the timeline plots is filtered data.

4.5 RELATIONSHIP BETWEEN AIR QUALITY PARAMETERS

Scatter plots summarizing the relationship between air quality parameters can be found in Appendix C.

A direct relationship between particle light scattering (b_{sp}) and total $PM_{2.5}$ is not possible to determine because different components of the $PM_{2.5}$ have different light scattering efficiencies, and the b_{sp} is measured in ambient RH conditions, but the $PM_{2.5}$ is determined under fairly dry conditions. The TEOM inlet was heated to 30º C from March through October with a naphion dryer and 50º C for the remainder of the year. The scatter plots in Figure C-1 shows a variable relationship which depends on the season. This variability is likely due in part to periods of higher sustained relative humidity in the 1st and 4th quarters. The R^2 between $PM_{2.5}$ and light scattering is shown to range from 0.30 to 0.66.

The relationship between maximum daily 1-hr average ozone and 24-hr average $PM_{2.5}$ is illustrated in Figure C-2. The maximum daily 1-hr average was used as the metric for comparison with 24-hr average $PM_{2.5}$ because it is believed to be a better indicator of the overall photochemical productivity, which tends to increase the rate of formation of sulfate, nitrate, and some organic aerosols which contribute to the $PM_{2.5}$ mass (Parkhurst, *et al.*)[3]. The scatter plots show a variable relationship which depends on the season. There is a significant correlation between ozone and $PM_{2.5}$ during the 2nd and 3rd quarters (R^2 = 0.50, 0.62) and no correlation during the 1st and 4th quarters (R^2 = 0.00, 0.00)

[3] Parkhurst, W.J., R.L. Tanner, F.P. Weatherford, R.J. Valente, and J.F. Meagher, *Historic $PM_{2.5}/PM_{10}$ Concentrations in the South Eastern United States – Potential Implications of the Revised Particulate Matter Standard*, Journal of the Air & Waste Management Association, Volume 49, September 1999.

4.6 OZONE DATA

The following data products summarize the ozone data collected during the reporting period, January 1, 2002 – December 31, 2002 and can be found in Appendix D:

- 10 Highest Daily 1-Hour Average Maximum Concentration Tables;
- Pollutant roses;
- Monthly bar charts illustrating the highest hourly average, highest 8-hour average and the monthly average; and
- Diurnal plots.

4.7 NEPHELOMETER DATA

The following data products summarize the ambient nephelometer data collected during the reporting period, January 1, 2002 – December 31, 2002 and can be found in Appendix E:

- Quarterly Data Summaries showing 4- and 24-hour average particle scattering; and
- Diurnal plots.

Operational timelines for the nephelometer and RH audit results that were provided in the preliminary reports can be found in Appendix F.

4.8 $PM_{2.5}$ DATA

The following data products summarize the $PM_{2.5}$ TEOM data collected during the reporting period, January 1, 2002 – December 31, 2002 and can be found in Appendix G:

- 10 Highest Daily 1-Hour Average Maximum Concentration Tables;
- Pollutant roses;
- Monthly bar charts illustrating the highest and second highest hourly average, highest 24-hour average and the monthly average; and
- Diurnal plots.

The TEOM inlet was heated to 30º C with a naphion dryer from March through October, and 50º C for the remainder of the year.

4.9 CAMERA DATA

A high resolution digital camera system is located at the Mayville site and operates as part of the MidWest haze camera network. Figure 4-1 provides a feel for the range of conditions observed during the January 1, 2002, through December 31, 2002 period. The associated hourly monitored values of particle scattering, $PM_{2.5}$ mass, ozone and relative humidity are presented for reference. It is important to remember that each of these measurements is made at a single

location, and the visual image represents an extended sight path. The visual quality of the scene is affected differently by each major $PM_{2.5}$ species, and by relative humidity. Therefore, none of the measured air quality parameters alone will completely determine the visual quality of the photographic image.

Mayville, Wisconsin
6/02/02 1100 hr
b_{sp} = 12 Mm^{-1}
Ozone = .03 ppm
$PM_{2.5}$ = .3 ug/m^3
RH = 53.76%

Mayville, Wisconsin
6/23/02 1500 hr
b_{sp} = 161 Mm^{-1}
Ozone = .082 ppm
$PM_{2.5}$ = 34.1 ug/m^3
RH = 42.85%

Figure 4-1. Photographs illustrating the conditions at Mayville Wisconsin

APPENDIX A

METEOROLOGICAL SUMMARY STATISTICS

Summary of Selected Meteorological Data

Mayville Visibility Study

Final Validation

01/01/2002 - 03/31/2002

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	5.1	m/s	2110	2.2
Maximum	14.6	m/s		
Percent calm = 1.42				
AMBIENT TEMPERATURE				
Average	-2.9	degC	2153	5.6
Maximum	13.8	degC		
Minimum	-23.4	degC		
RELATIVE HUMIDITY				
Average	81	percent	2160	16
Maximum	100	percent		
Minimum	25	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	NA			
Maximum non-zero rate				
Minimum non-zero rate				
Accumulated during period				
SOLAR RADIATION				
Average Daily Total	191.979	ly/day	87	96.512
Maximum Daily Total	448.800	ly/day		
Minimum Daily Total	30.600	ly/day		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

NA indicates instrument not available.

Summary of Selected Meteorological Data

Mayville Visibility Study

Final Validation

04/01/2002 - 06/30/2002

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	4.5	m/s	2181	2.1
Maximum	12.4	m/s		
Percent calm = 1.28				
AMBIENT TEMPERATURE				
Average	13.0	degC	2151	8.7
Maximum	32.8	degC		
Minimum	-5.2	degC		
RELATIVE HUMIDITY				
Average	73	percent	2154	20
Maximum	100	percent		
Minimum	21	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	NA			
Maximum non-zero rate				
Minimum non-zero rate				
Accumulated during period				
SOLAR RADIATION				
Average Daily Total	415.193	ly/day	89	175.183
Maximum Daily Total	667.200	ly/day		
Minimum Daily Total	46.200	ly/day		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

NA indicates instrument not available.

Summary of Selected Meteorological Data

Mayville Visibility Study

Final Validation

07/01/2002 - 09/30/2002

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	3.3	m/s	2204	1.5
Maximum	10.1	m/s		
Percent calm = 2.45				
AMBIENT TEMPERATURE				
Average	20.8	degC	2196	5.1
Maximum	34.1	degC		
Minimum	3.7	degC		
RELATIVE HUMIDITY				
Average	73	percent	2198	17
Maximum	100	percent		
Minimum	31	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	NA			
Maximum non-zero rate				
Minimum non-zero rate				
Accumulated during period				
SOLAR RADIATION				
Average Daily Total	438.987	ly/day	90	147.668
Maximum Daily Total	669.600	ly/day		
Minimum Daily Total	88.200	ly/day		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

NA indicates instrument not available.

Summary of Selected Meteorological Data

Mayville Visibility Study

Final Validation

10/01/2002 - 12/31/2002

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	4.4	m/s	2133	2.0
Maximum	11.4	m/s		
Percent calm = 2.20				
AMBIENT TEMPERATURE				
Average	1.1	degC	1817	7.1
Maximum	23.9	degC		
Minimum	-14.4	degC		
RELATIVE HUMIDITY				
Average	73	percent	1892	15
Maximum	100	percent		
Minimum	28	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	NA			
Maximum non-zero rate				
Minimum non-zero rate				
Accumulated during period				
SOLAR RADIATION				
Average Daily Total	135.779	ly/day	84	73.541
Maximum Daily Total	339.600	ly/day		
Minimum Daily Total	25.800	ly/day		

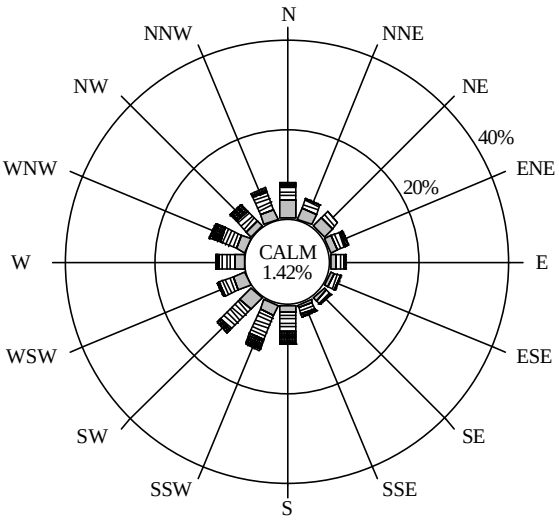
Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

NA indicates instrument not available.

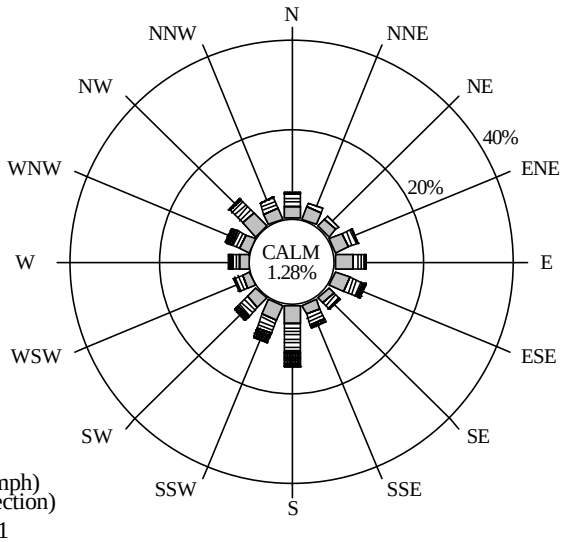
Mayville Visibility Study Quarterly Wind Rose 2002

FIRST QUARTER (JAN-MAR)



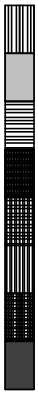
97.7% Collected 97.7% Valid
2160 Possible /2110 Collected /2110 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)



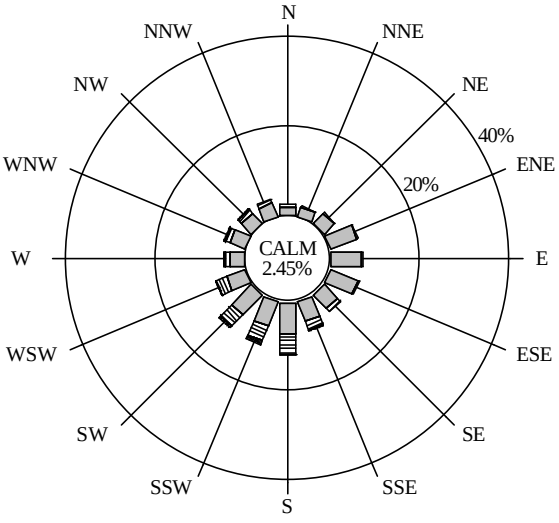
99.9% Collected 99.9% Valid
2183 Possible /2181 Collected /2181 Valid
(includes WS and WD)

Scalar Wind Speed (mph)
(vs Scalar Wind Direction)



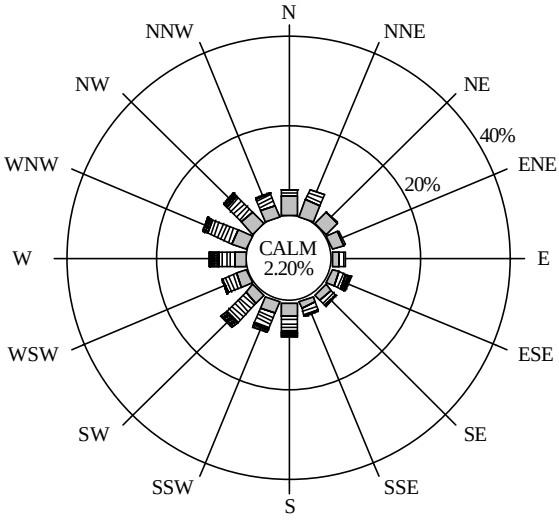
CALM < 1
1.0-1.9
2.0-8.9
9.0-15.9
16.0-22.9
23.0-29.9
30.0-36.9
37.0-43.9
44.0+

THIRD QUARTER (JUL-SEP)



99.8% Collected 99.8% Valid
2208 Possible /2204 Collected /2204 Valid
(includes WS and WD)

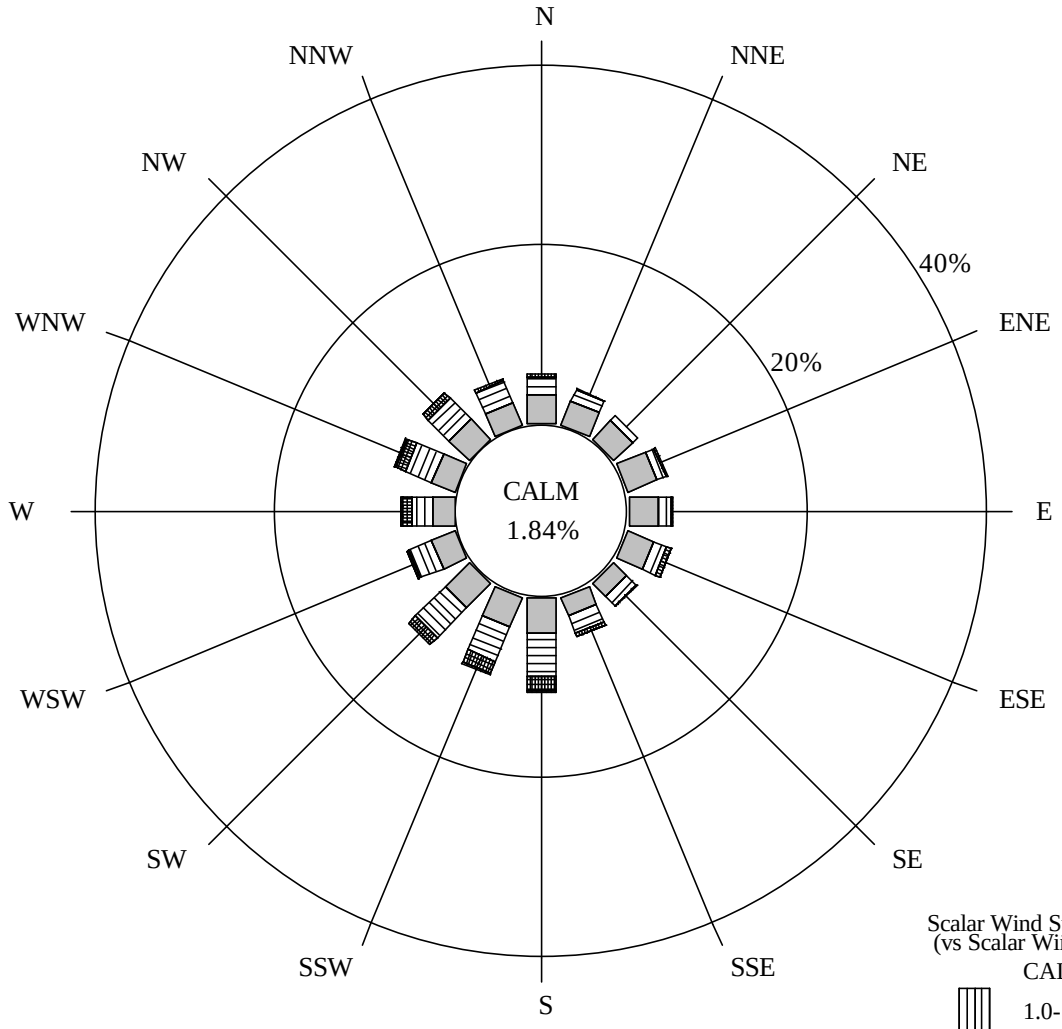
FOURTH QUARTER (OCT-DEC)



99.9% Collected 96.6% Valid
2208 Possible /2206 Collected /2133 Valid
(includes WS and WD)

Validation Level 0

06-16-2003



99.3% Collected 98.5% Valid

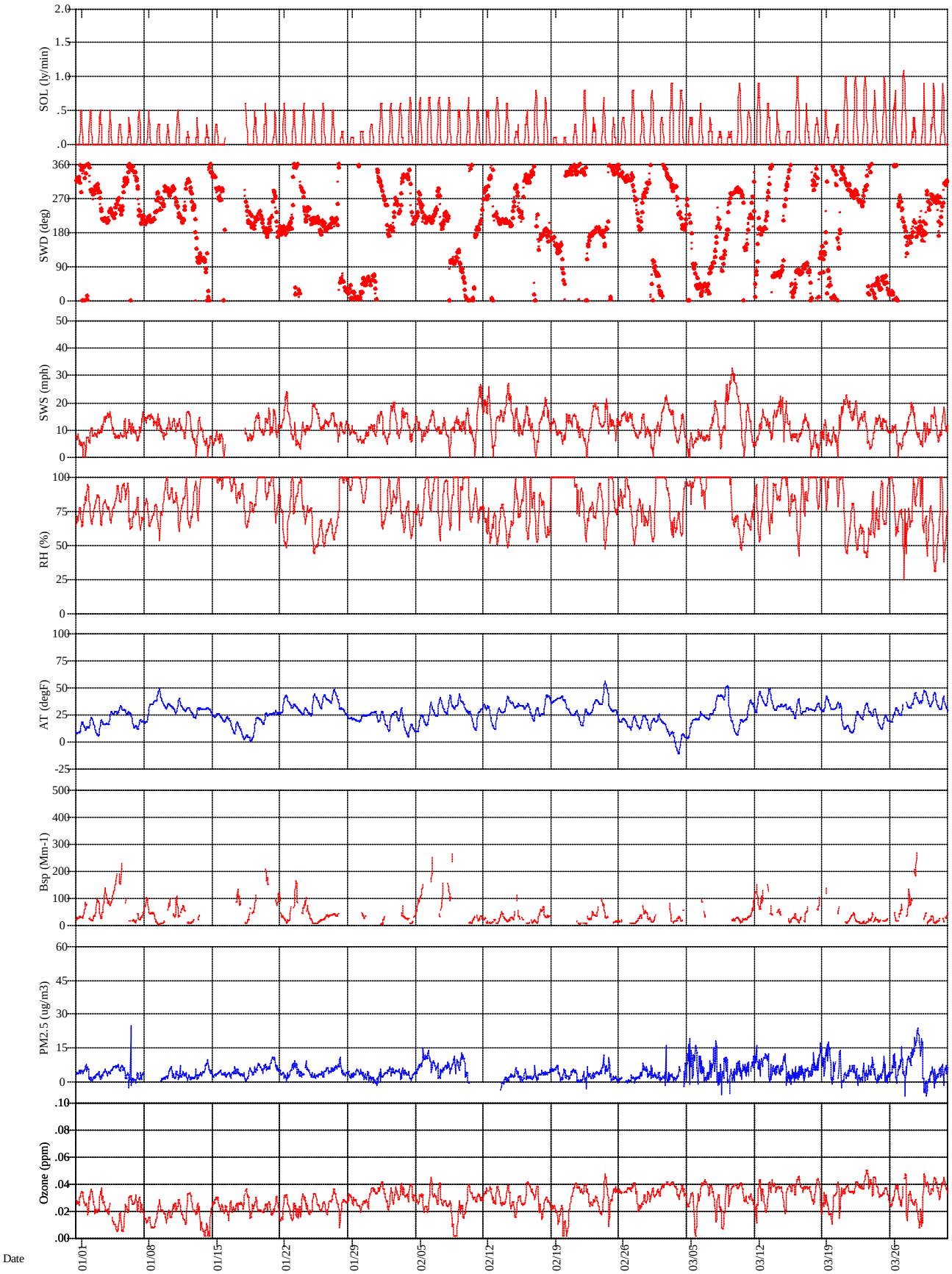
8759 Possible /8701 Collected /8628 Valid

(includes WD and WS)
(SWD-1) (SWS-2)

APPENDIX B

TIMELINE OF AIR QUALITY AND METEOROLOGICAL DATA

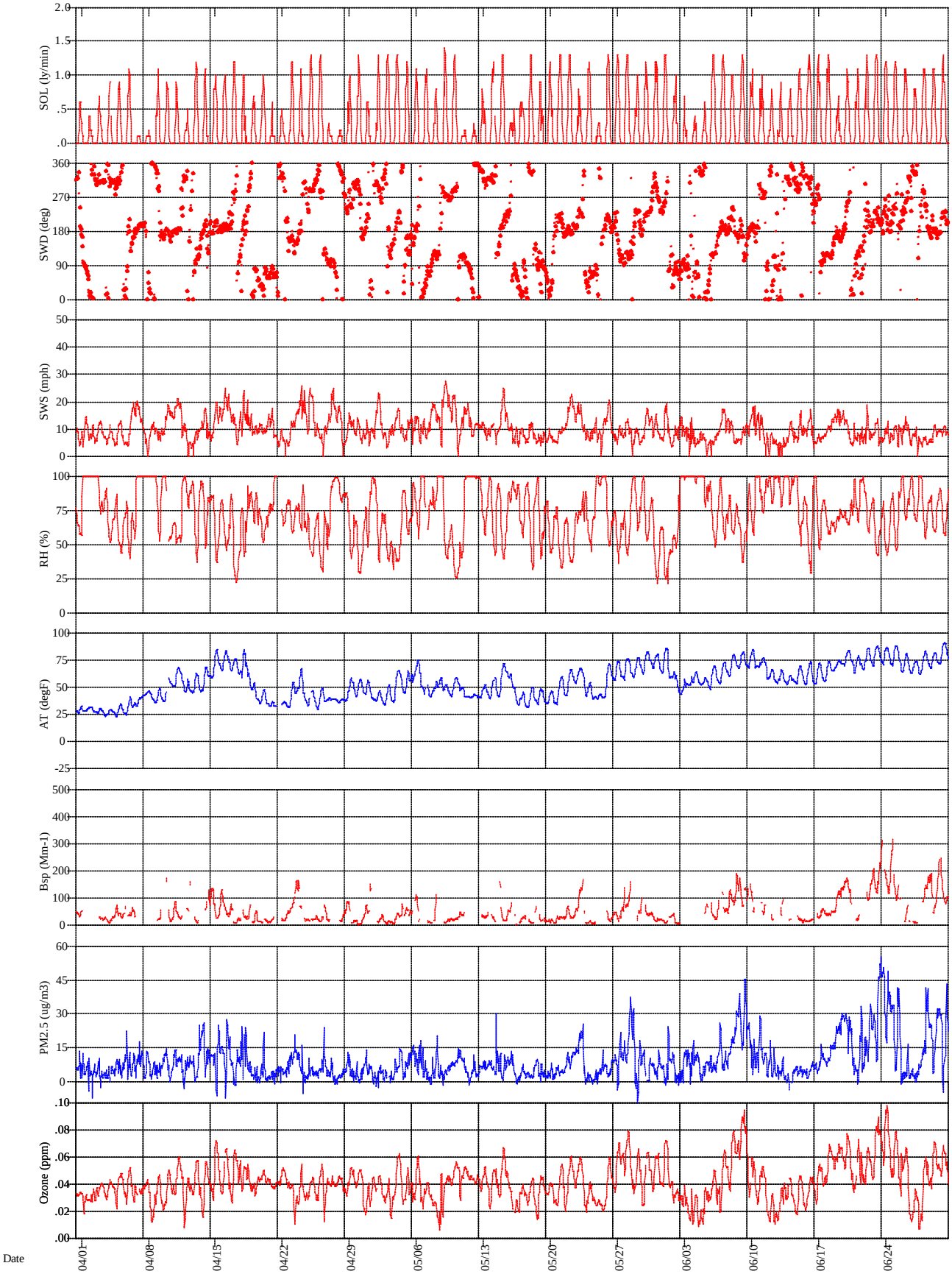
Mayville, Wisconsin



Final Data

January - March 2002

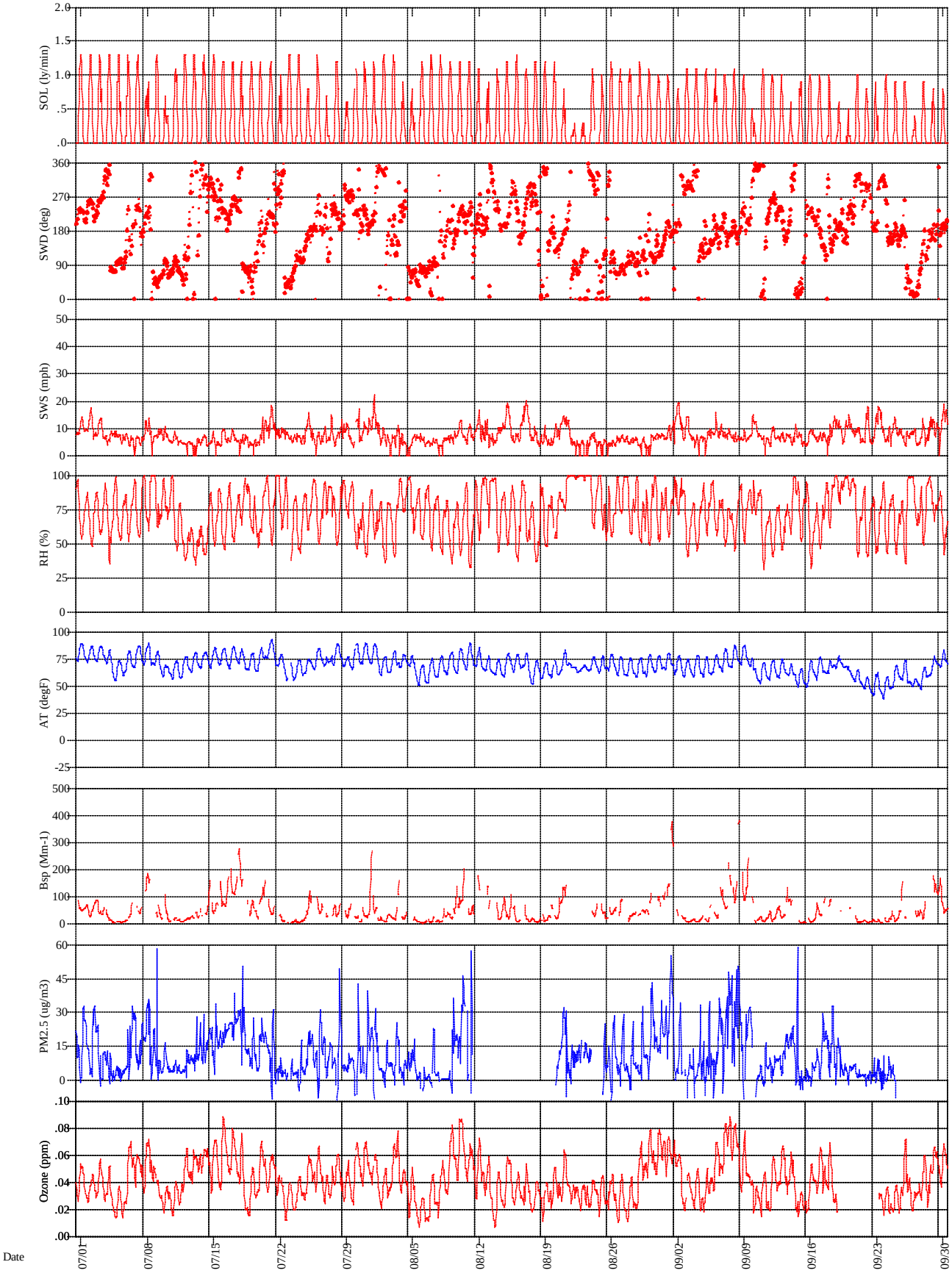
Mayville, Wisconsin



Final Data

April - June 2002

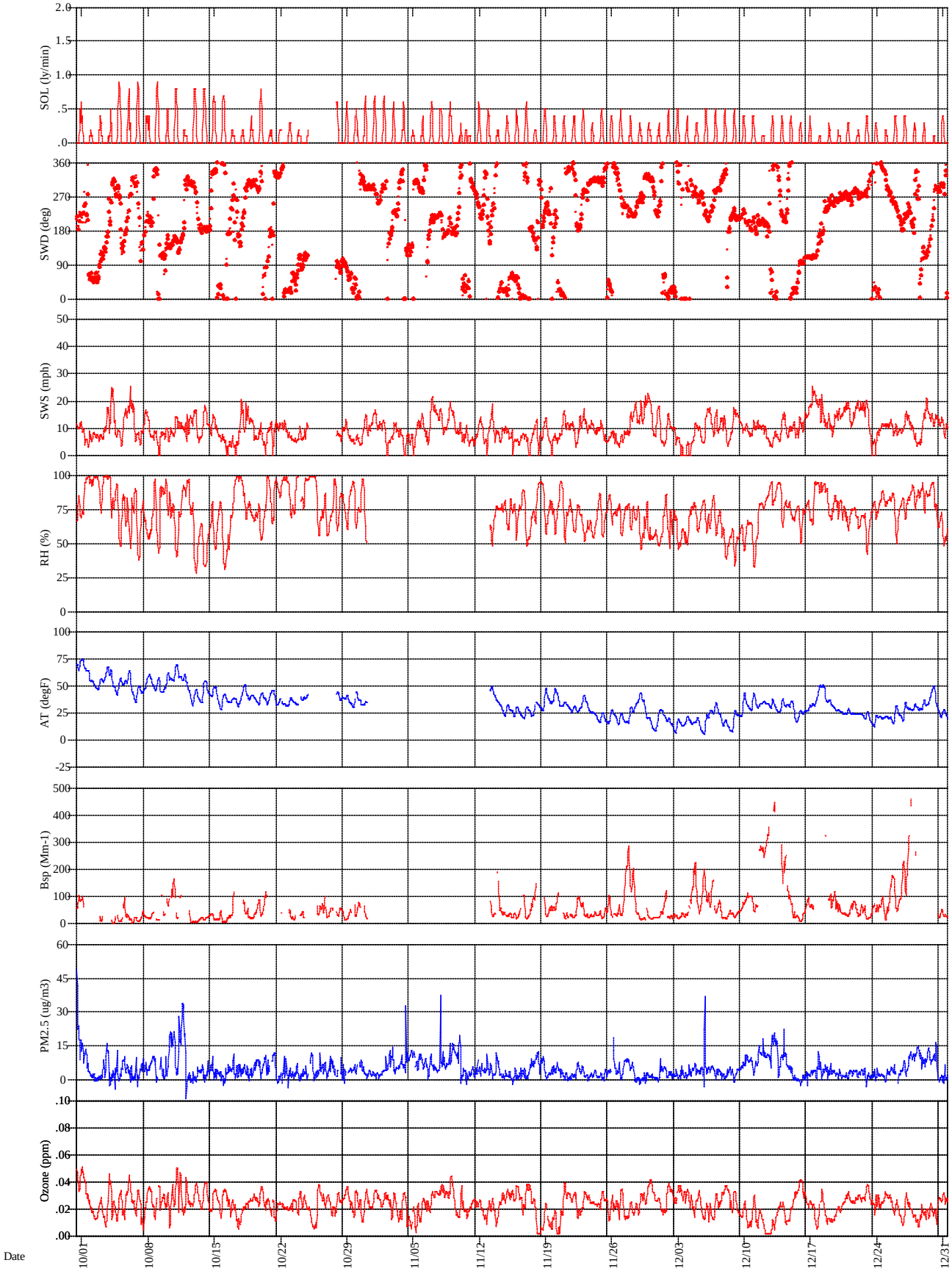
Mayville, Wisconsin



Final Data

July - September 2002

Mayville, Wisconsin



Final Data

October - December 2002

APPENDIX C

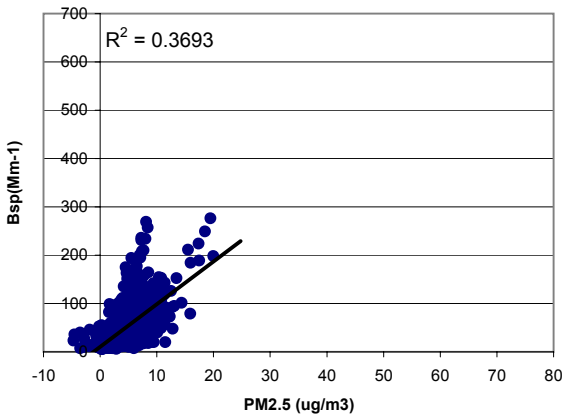
SCATTER PLOTS
AIR QUALITY PARAMETERS

Mayville Visibility Study

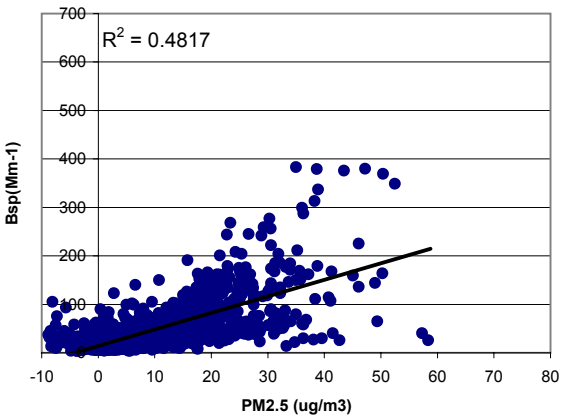
Figure C-1
Quarterly Scatter Plots
Light Scattering (Bsp) VS. PM2.5

2002

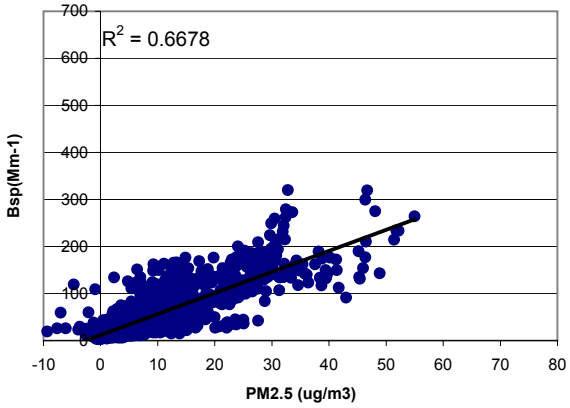
First Quarter (JAN - MAR)



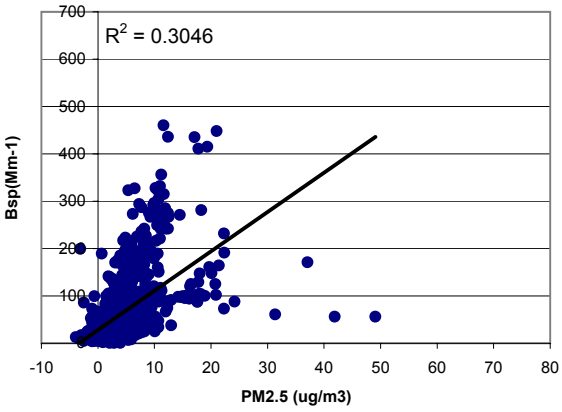
Third Quarter (JUL - SEP)



Second Quarter (APR - JUN)



Fourth Quarter (OCT - DEC)

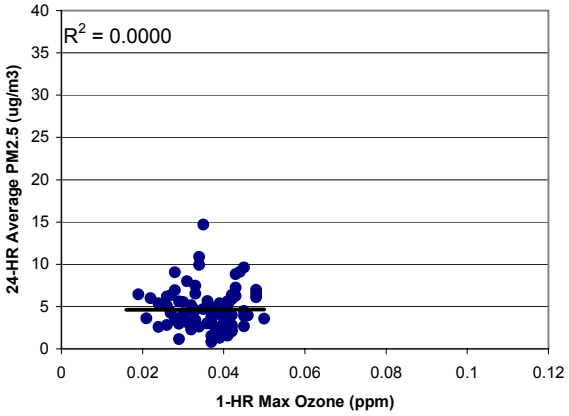


Mayville Visibility Study

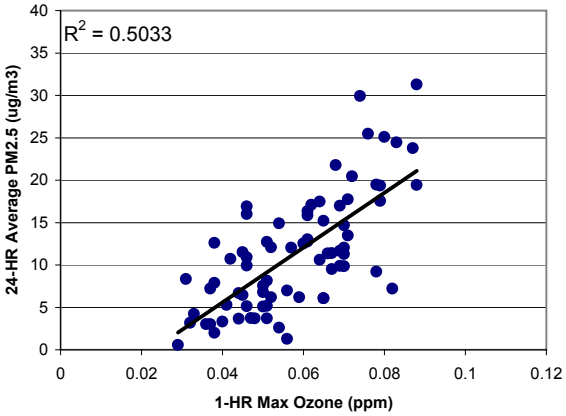
Figure C-2
Quarterly Scatter Plots
Ozone VS. PM2.5

2002

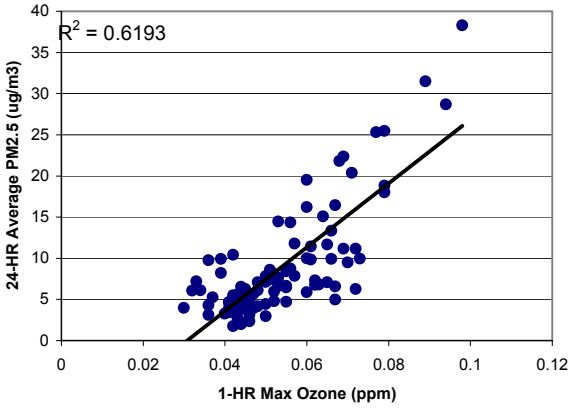
First Quarter (JAN - MAR)



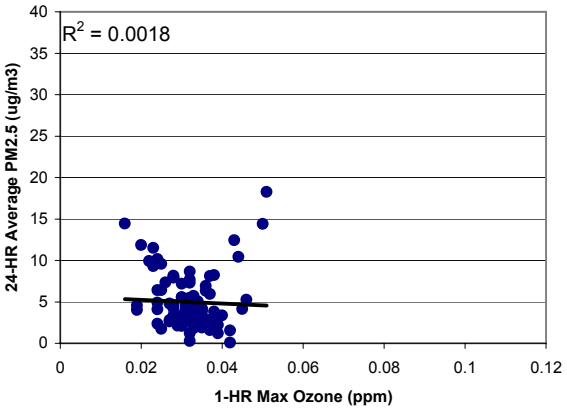
Third Quarter (JUL - SEP)



Second Quarter (APR - JUN)



Fourth Quarter (OCT - DEC)



APPENDIX D

OZONE SUMMARY DATA PRODUCTS

Ozone

10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

Final Validation
01/01/2002 - 03/31/2002

Value	Date	Hour	Concentration (ppm)
Ozone			
1	03/23/2002	15	0.050*
2	02/24/2002	15	0.048
3	03/27/2002	15	0.048
4	03/29/2002	14	0.048
5	03/16/2002	15	0.046
6	02/06/2002	15	0.045
7	03/24/2002	9	0.045*
8	03/30/2002	14	0.045
9	03/31/2002	15	0.045
10	03/18/2002	15	0.044**

* This value was also recorded during one or more hours later in the day.
** This value was also recorded on one or more days later in the reported period.

Ozone

10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

Final Validation
04/01/2002 - 06/30/2002

Value	Date	Hour	Concentration (ppm)
Ozone			
1	06/24/2002	15	0.098
2	06/09/2002	16	0.094
3	06/23/2002	16	0.089
4	05/28/2002	14	0.079
5	06/08/2002	14	0.079*
6	06/25/2002	13	0.079
7	06/20/2002	11	0.077
8	06/21/2002	15	0.073
9	04/15/2002	14	0.072
10	06/01/2002	12	0.072* **

* This value was also recorded during one or more hours later in the day.
** This value was also recorded on one or more days later in the reported period.

Ozone

10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

Final Validation
07/01/2002 - 09/30/2002

Value	Date	Hour	Concentration (ppm)
Ozone			
1	07/16/2002	12	0.088
2	09/08/2002	1	0.088
3	08/10/2002	11	0.087*
4	09/07/2002	13	0.083*
5	08/09/2002	17	0.082
6	07/17/2002	12	0.080
7	08/30/2002	15	0.079
8	08/31/2002	14	0.079
9	08/03/2002	22	0.078
10	09/09/2002	14	0.078

* This value was also recorded during one or more hours later in the day.

Ozone

10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

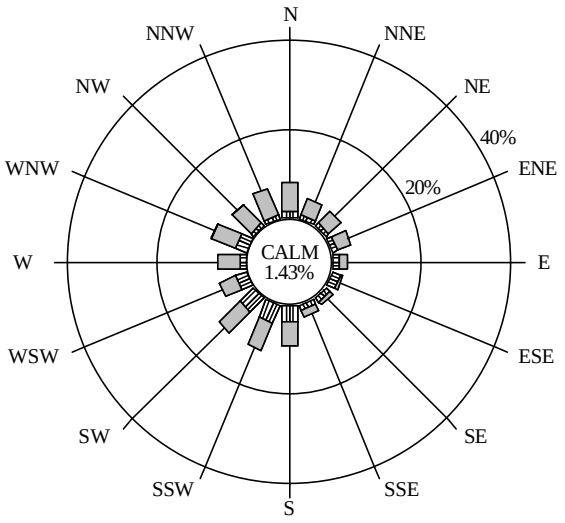
Final Validation
10/01/2002 - 12/31/2002

Value	Date	Hour	Concentration (ppm)
Ozone			
1	10/01/2002	14	0.051
2	10/11/2002	13	0.050*
3	10/04/2002	9	0.046
4	10/06/2002	13	0.045
5	11/09/2002	13	0.044*
6	10/12/2002	13	0.043
7	11/30/2002	14	0.042*
8	12/16/2002	10	0.042*
9	10/14/2002	15	0.040
10	10/13/2002	15	0.039**

* This value was also recorded during one or more hours later in the day.
** This value was also recorded on one or more days later in the reported period.

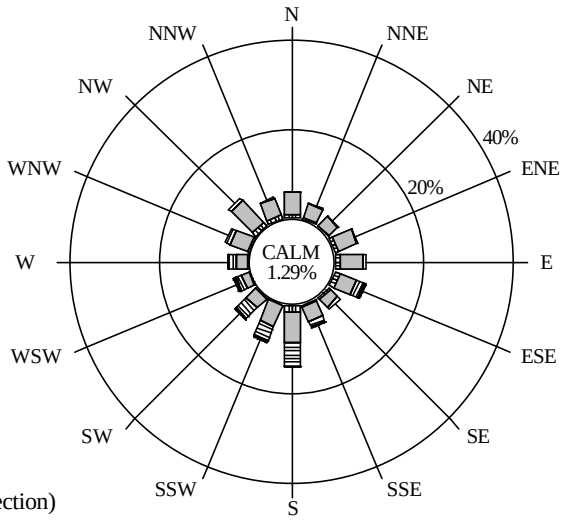
Mayville Visibility Study | Quarterly Ozone Pollutant Rose | 2002

FIRST QUARTER (JAN-MAR)



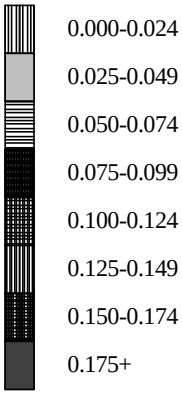
97.7% Collected 96.9% Valid
2160 Possible /2110 Collected /2093 Valid

SECOND QUARTER (APR-JUN)

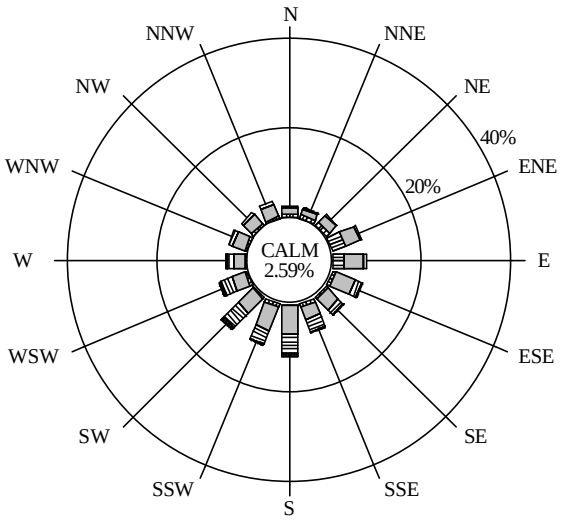


99.4% Collected 99.2% Valid
2183 Possible /2170 Collected /2166 Valid

Ozone (ppm)
(vs Scalar Wind Direction)

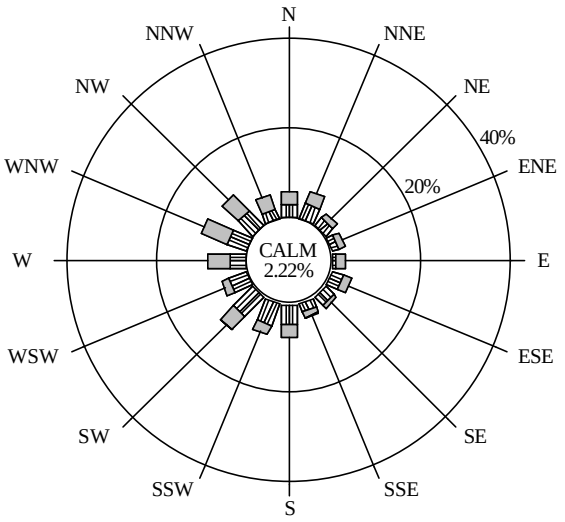


THIRD QUARTER (JUL-SEP)

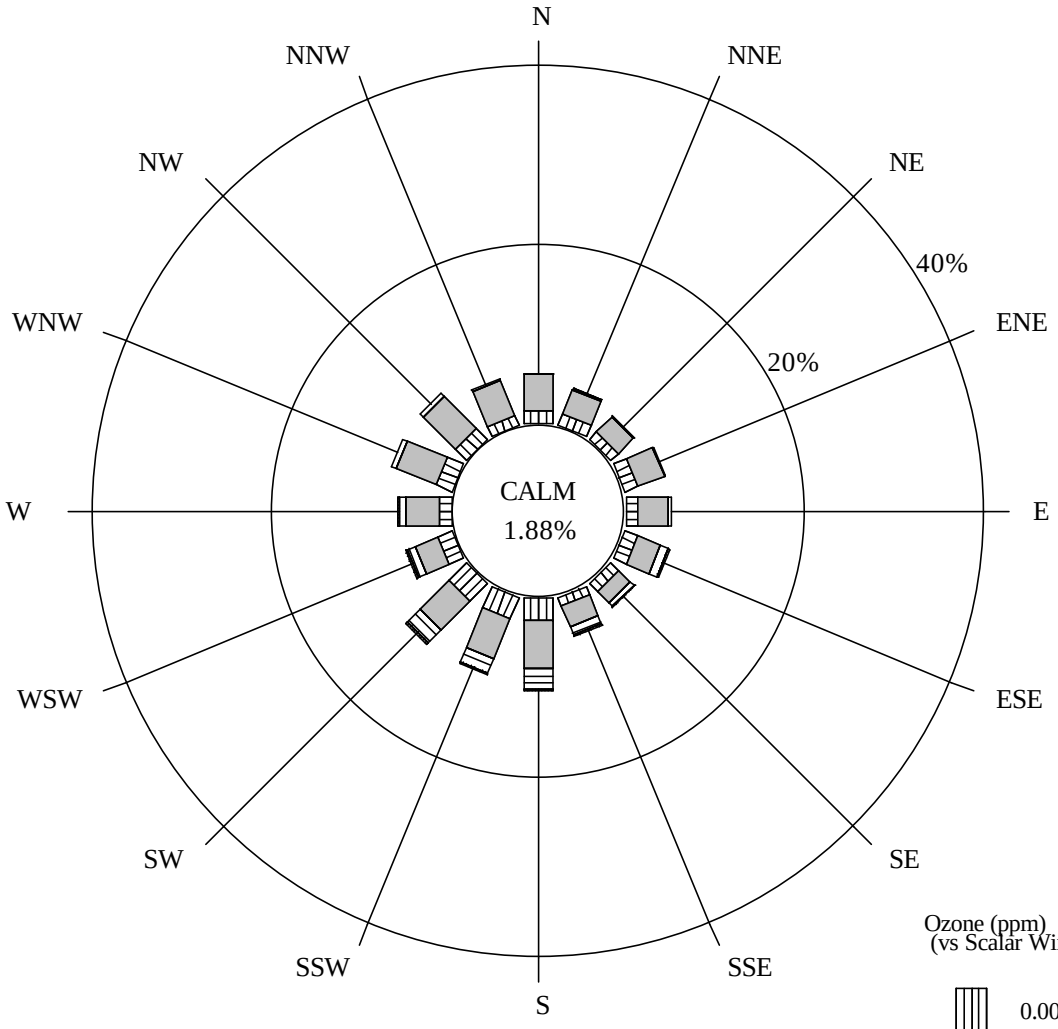


99.0% Collected 94.6% Valid
2208 Possible /2187 Collected /2088 Valid

FOURTH QUARTER (OCT-DEC)



99.5% Collected 96.1% Valid
2208 Possible /2196 Collected /2121 Valid

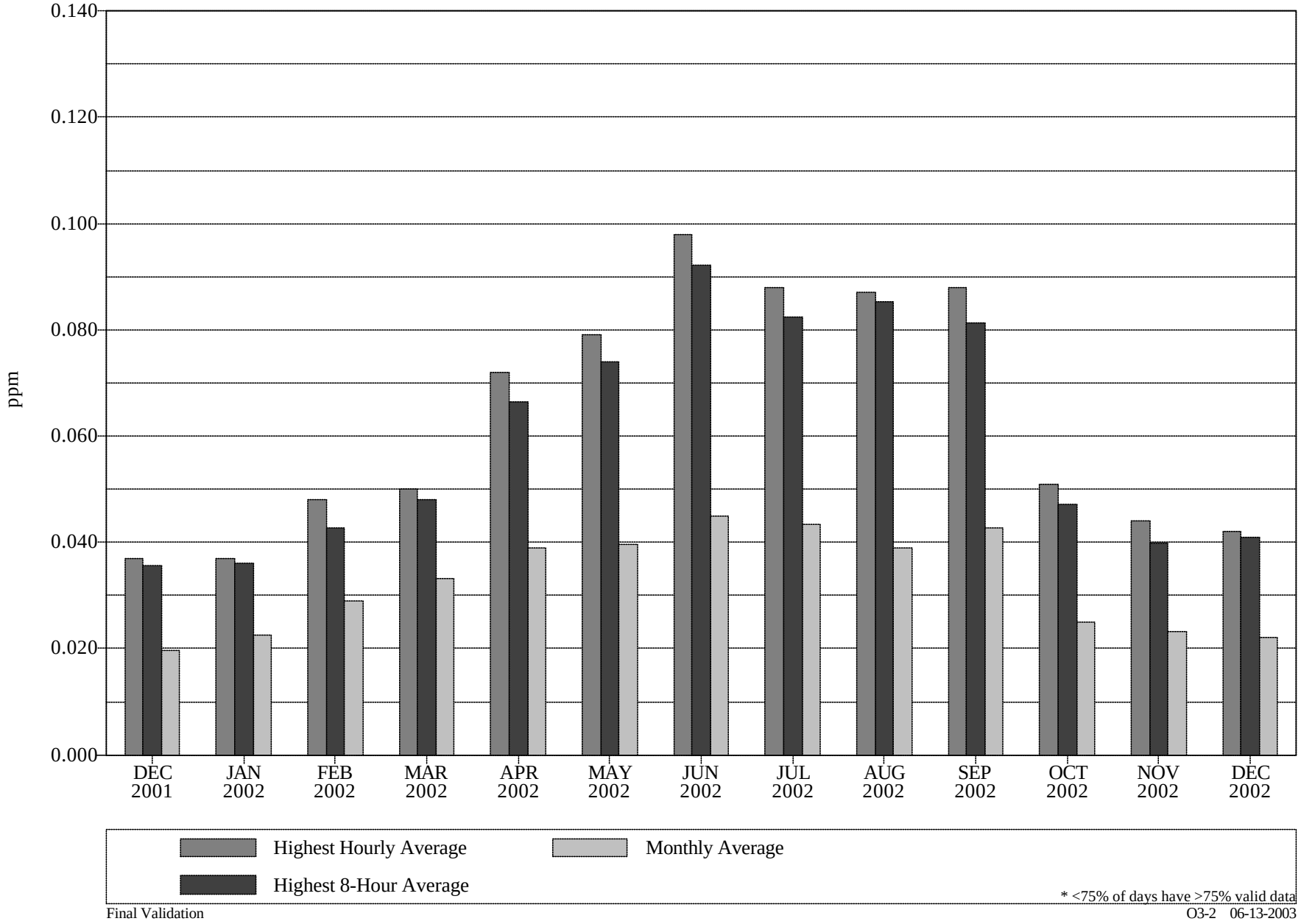


98.9% Collected 96.7% Valid
8759 Possible /8663 Collected /8468 Valid

Mayville Visibility Study

Ozone Data Summary by Month
December 2001 to December 2002

12/01/2001 - 12/31/2002



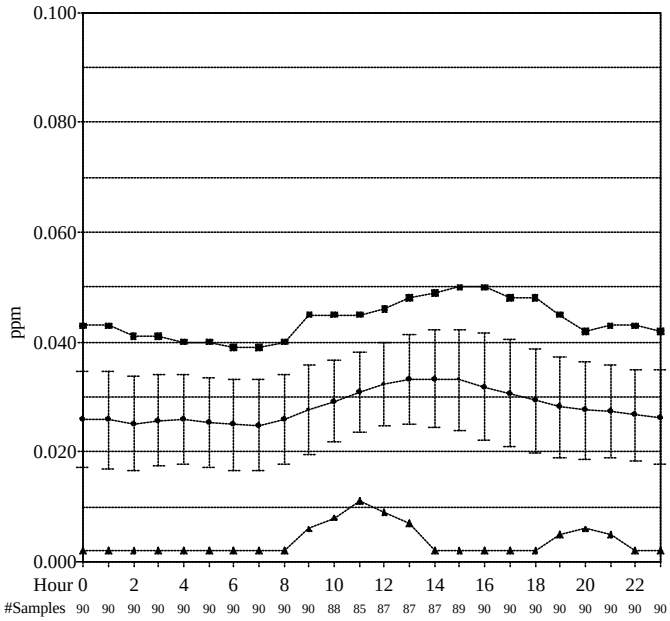
* <75% of days have >75% valid data

Final Validation

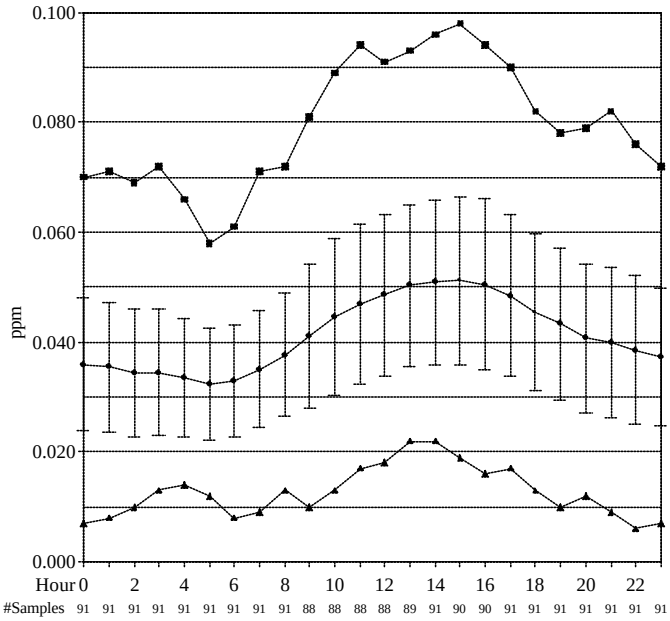
O3-2 06-13-2003

Mayville Visibility Study | Quarterly Diurnal Ozone Plots | 2002

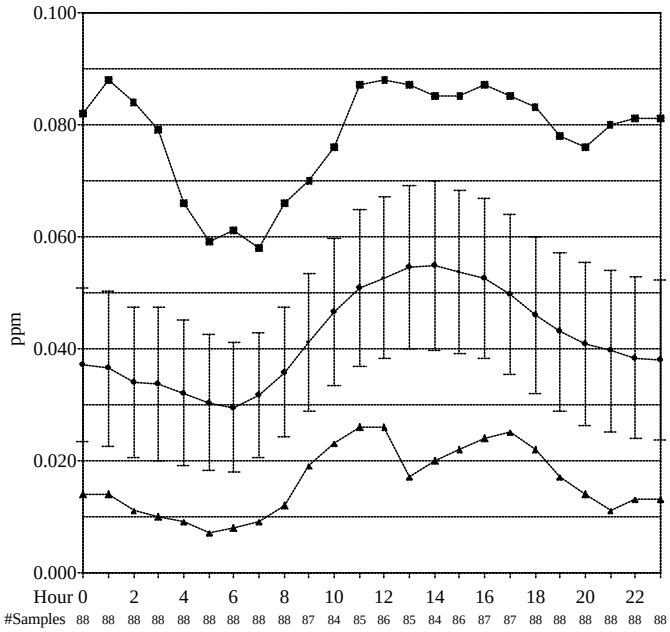
FIRST QUARTER (JAN-MAR)



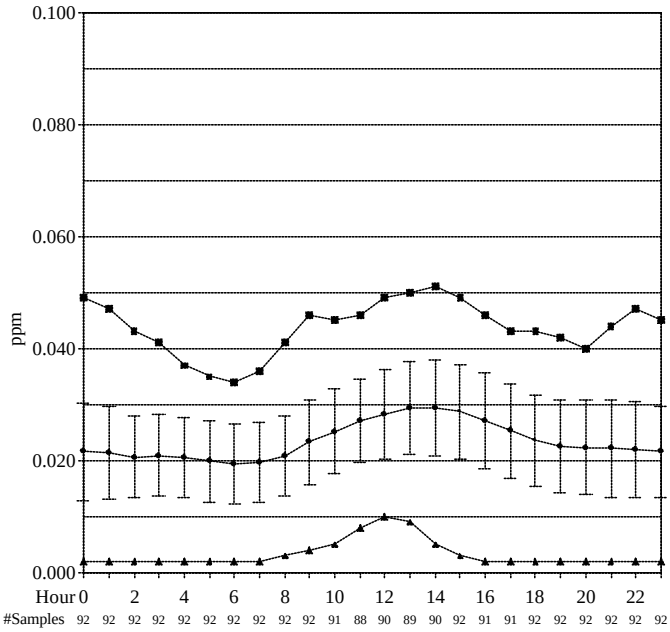
SECOND QUARTER (APR-JUN)

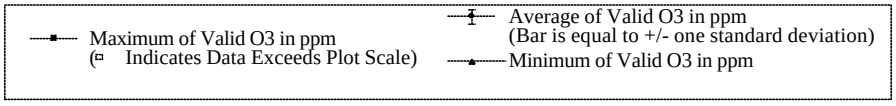


THIRD QUARTER (JUL-SEP)

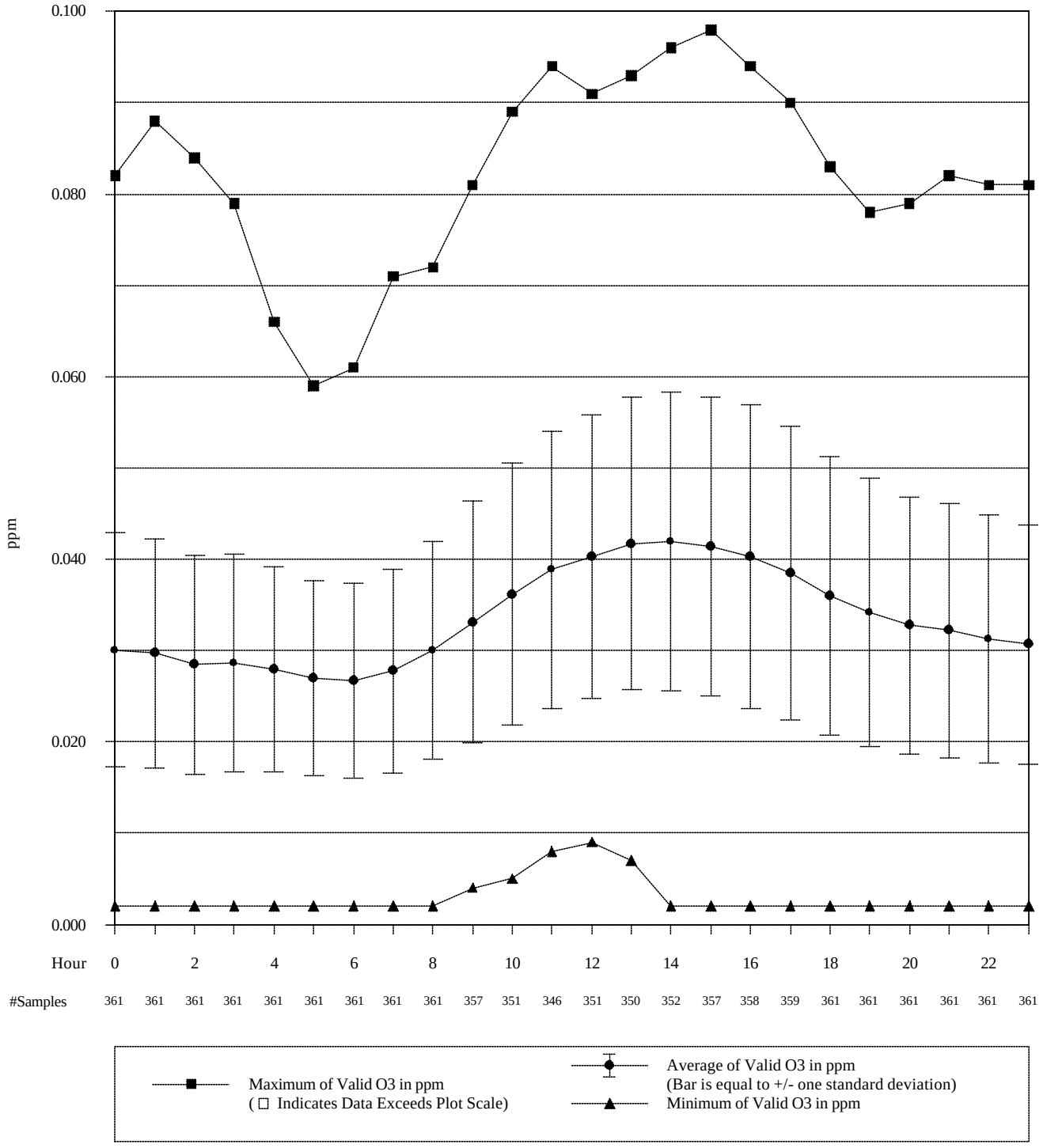


FOURTH QUARTER (OCT-DEC)





Mayville Visibility Study | Annual Diurnal Ozone Plot | 2002



Final Validation

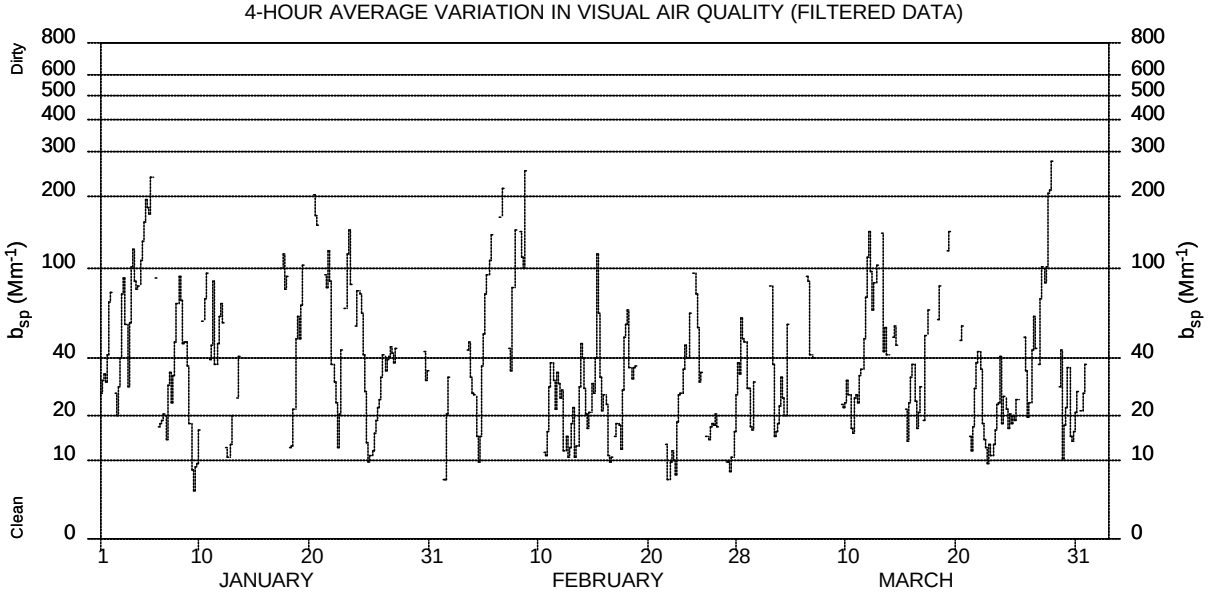
06-12-2003

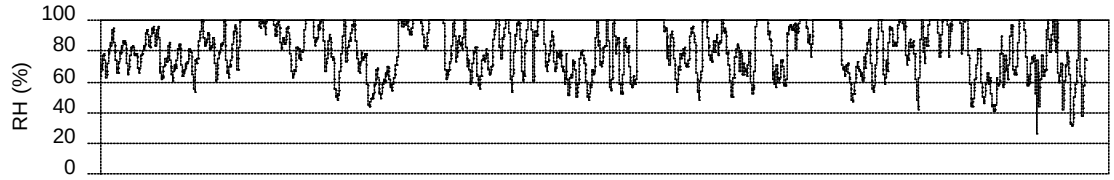
APPENDIX E

NEPHELOMETER SUMMARY DATA PRODUCTS

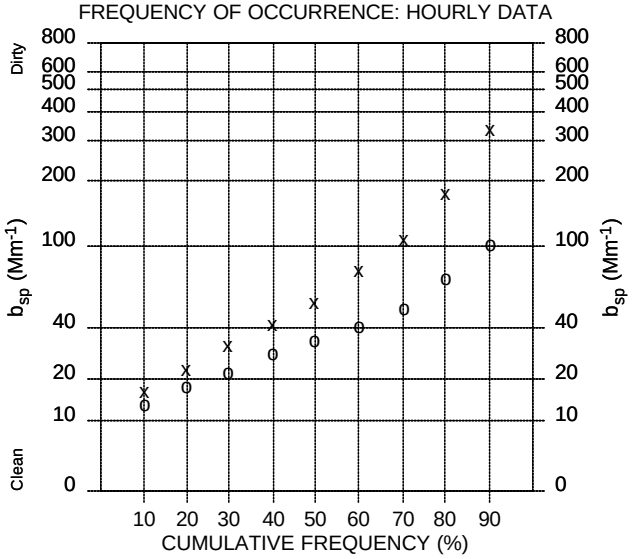
MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
First Quarter: January 1, 2002 - March 31, 2002

4-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)





FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	15.0	12.0
20	21.0	16.0
30	29.0	20.0
40	38.0	26.0
50	50.0	31.0
60	72.0	37.0
70	101.0	46.0
80	163.0	66.0
90	316.0	95.0

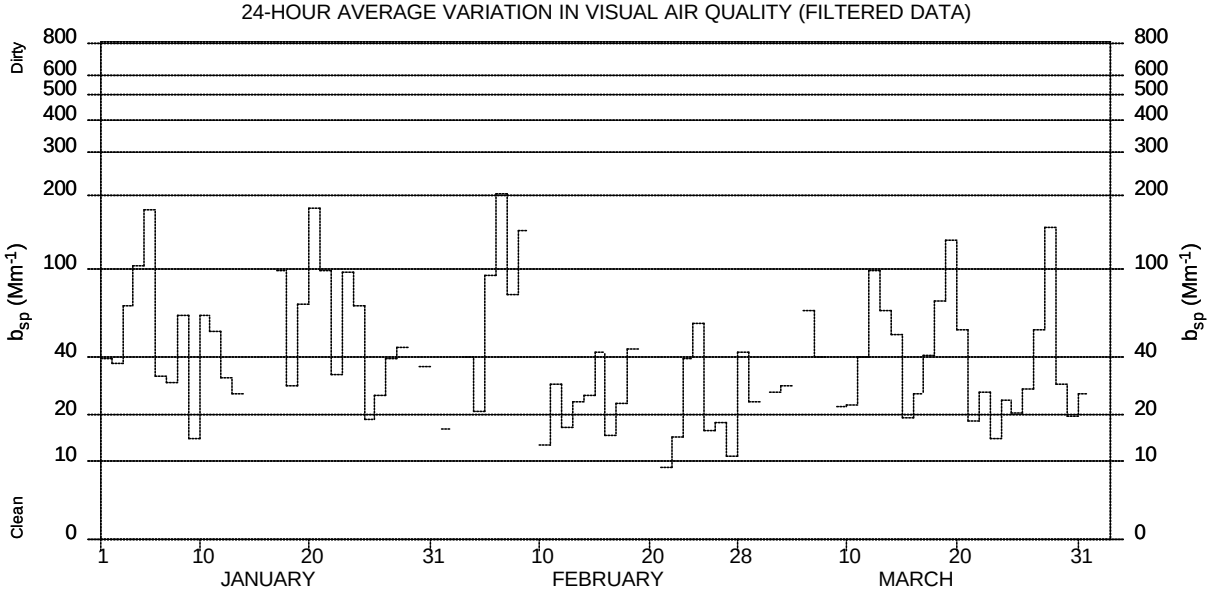
VISIBILITY METRIC (FILTERED DATA)

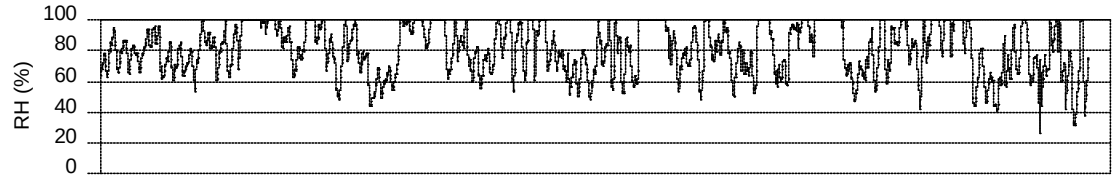
	b_{sp}
Mean of cleanest 20%	11.7
Mean of all data	44.3
Mean of dirtiest 20%	110.0

NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2160	100
Valid Hourly Averages (Filtered and Unfiltered)	2113	98
Valid Hourly Averages (Filtered)	1228	57
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		58

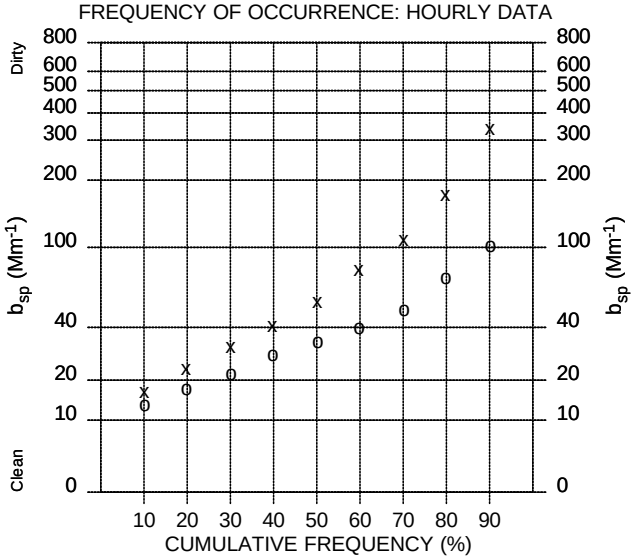
MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
First Quarter: January 1, 2002 - March 31, 2002

24-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)





FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	15.0	12.0
20	21.0	16.0
30	29.0	20.0
40	38.0	26.0
50	50.0	31.0
60	72.0	37.0
70	101.0	46.0
80	163.0	66.0
90	316.0	95.0

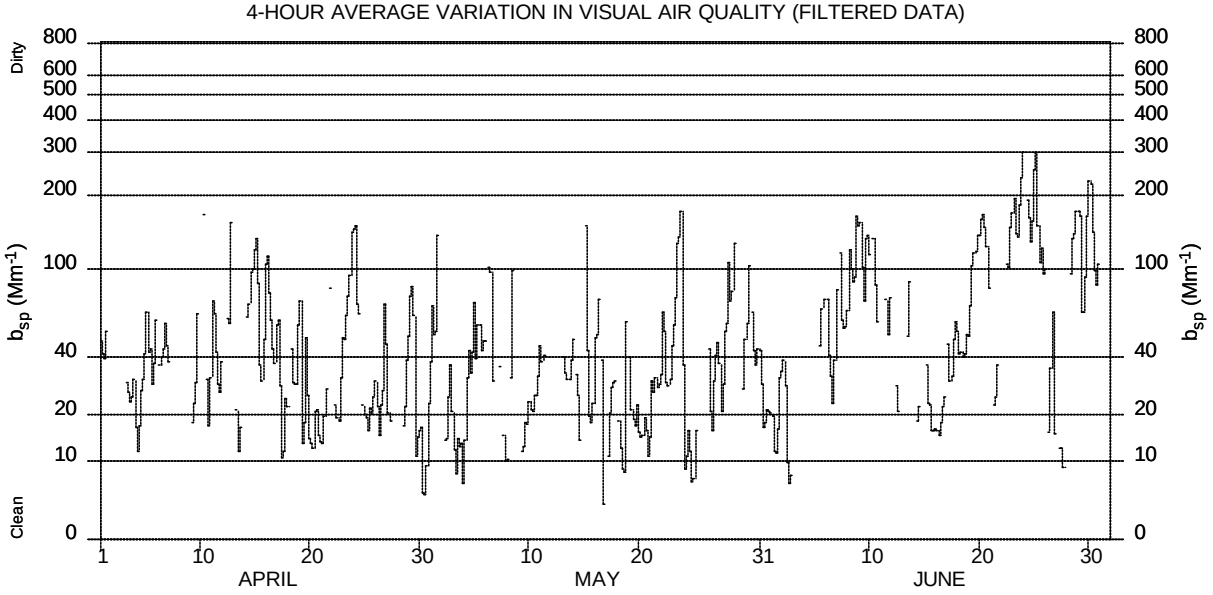
VISIBILITY METRIC (FILTERED DATA)

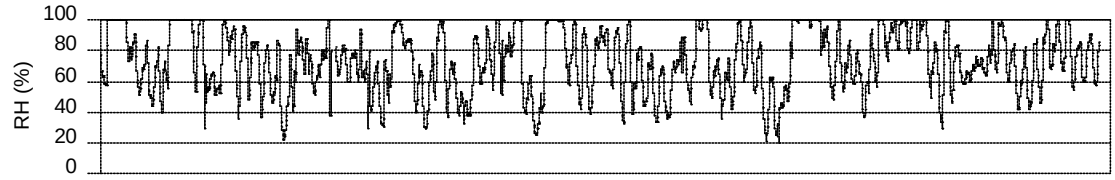
	b_{sp}
Mean of cleanest 20%	11.7
Mean of all data	44.3
Mean of dirtiest 20%	110.0

NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2160	100
Valid Hourly Averages (Filtered and Unfiltered)	2113	98
Valid Hourly Averages (Filtered)	1228	57
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		58

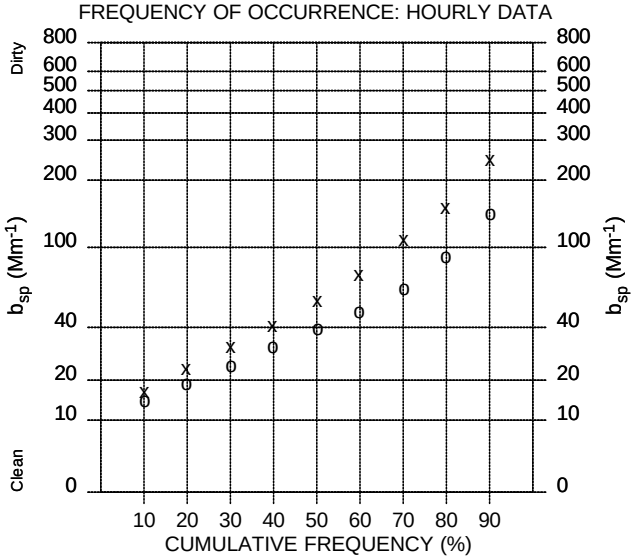
MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Second Quarter: April 1, 2002 - June 30, 2002

4-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)





FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	15.0	13.0
20	21.0	17.0
30	29.0	22.0
40	38.0	29.0
50	51.0	36.0
60	69.0	45.0
70	101.0	58.0
80	142.0	84.0
90	233.0	133.0

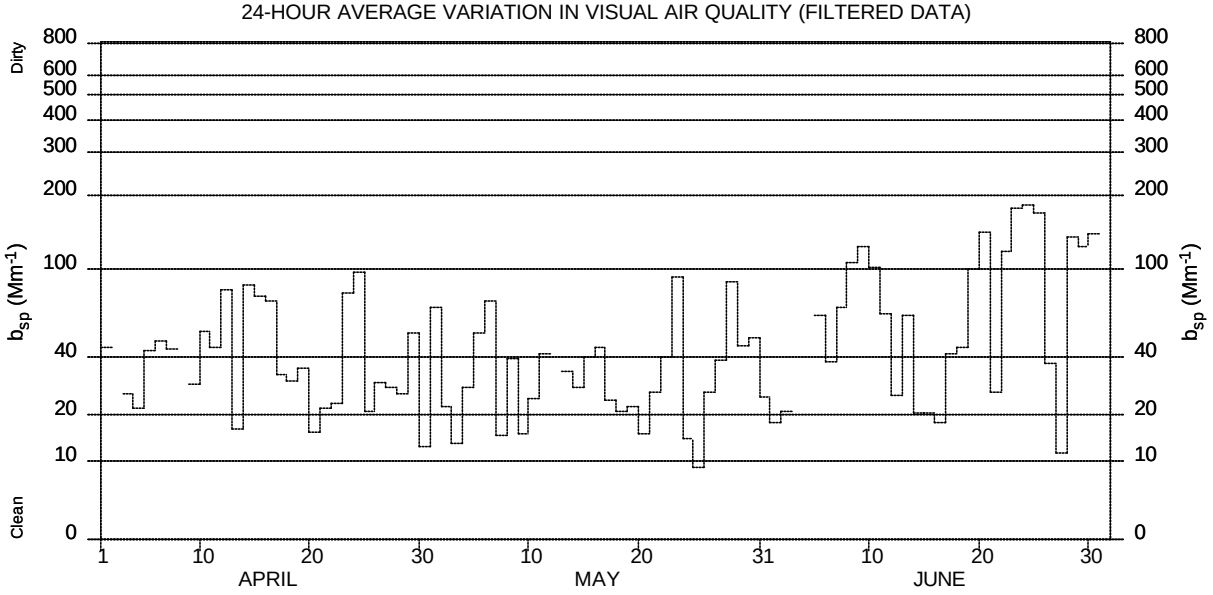
VISIBILITY METRIC (FILTERED DATA)

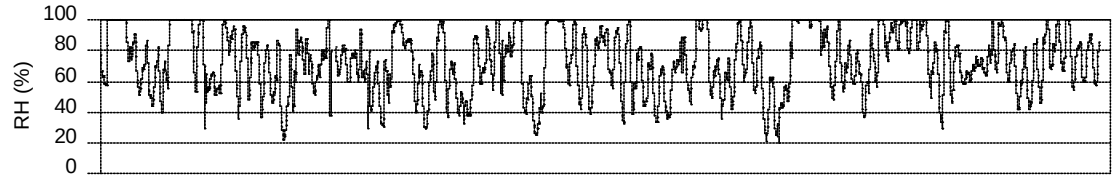
	b_{sp}
Mean of cleanest 20%	12.3
Mean of all data	54.1
Mean of dirtiest 20%	138.5

NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2184	100
Valid Hourly Averages (Filtered and Unfiltered)	2158	99
Valid Hourly Averages (Filtered)	1441	66
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		67

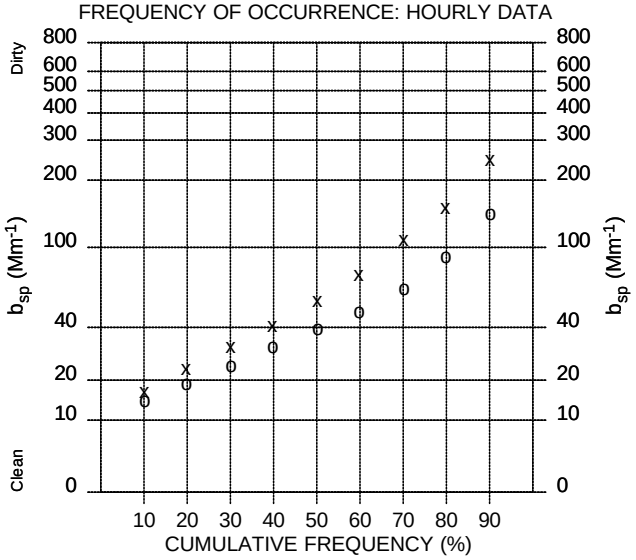
MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Second Quarter: April 1, 2002 - June 30, 2002

24-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)





FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	15.0	13.0
20	21.0	17.0
30	29.0	22.0
40	38.0	29.0
50	51.0	36.0
60	69.0	45.0
70	101.0	58.0
80	142.0	84.0
90	233.0	133.0

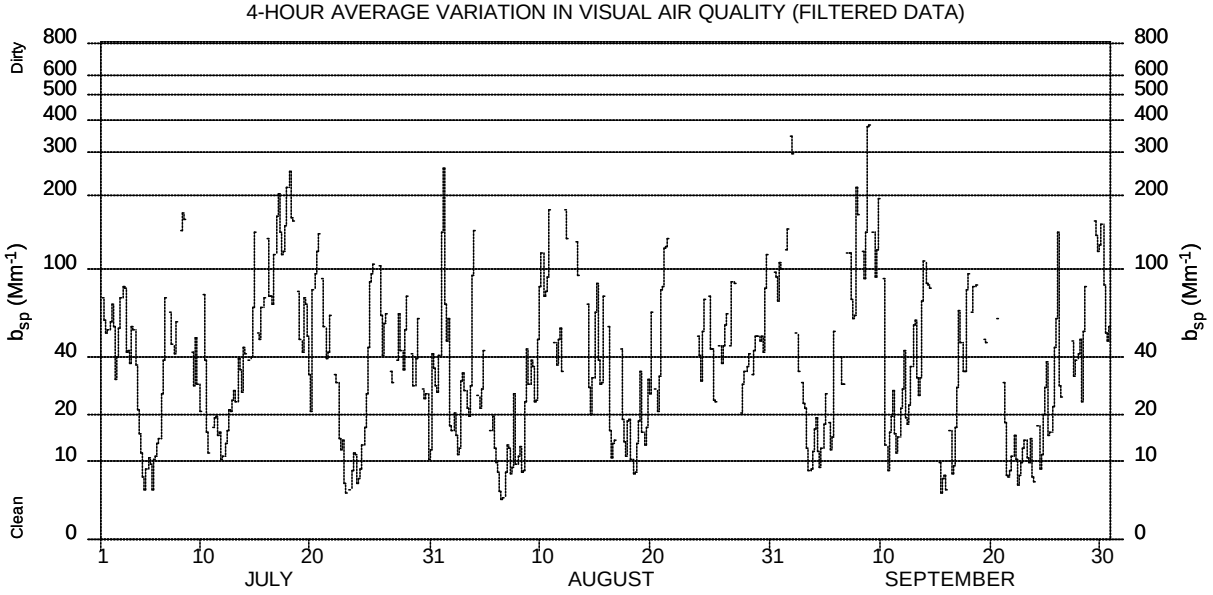
VISIBILITY METRIC (FILTERED DATA)

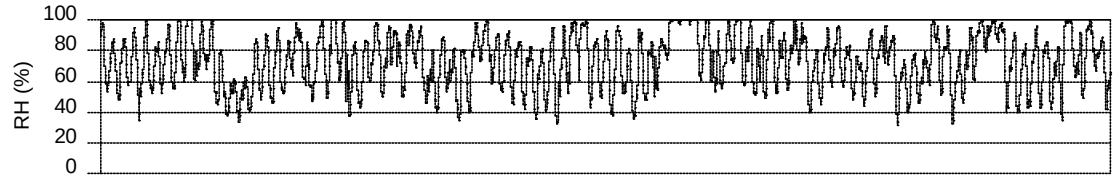
	b_{sp}
Mean of cleanest 20%	12.3
Mean of all data	54.1
Mean of dirtiest 20%	138.5

NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2184	100
Valid Hourly Averages (Filtered and Unfiltered)	2158	99
Valid Hourly Averages (Filtered)	1441	66
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		67

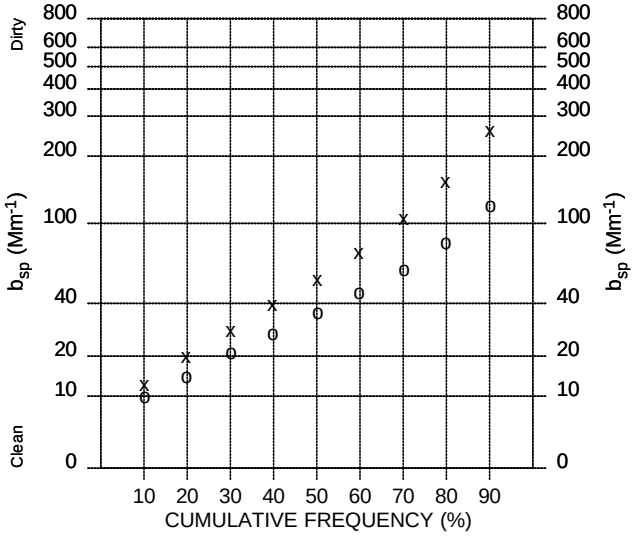
MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Third Quarter: July 1, 2002 - September 31, 2002

4-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)





FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	11.0	9.0
20	18.0	13.0
30	26.0	19.0
40	36.0	25.0
50	49.0	33.0
60	68.0	42.0
70	97.0	55.0
80	145.0	75.0
90	244.0	112.0

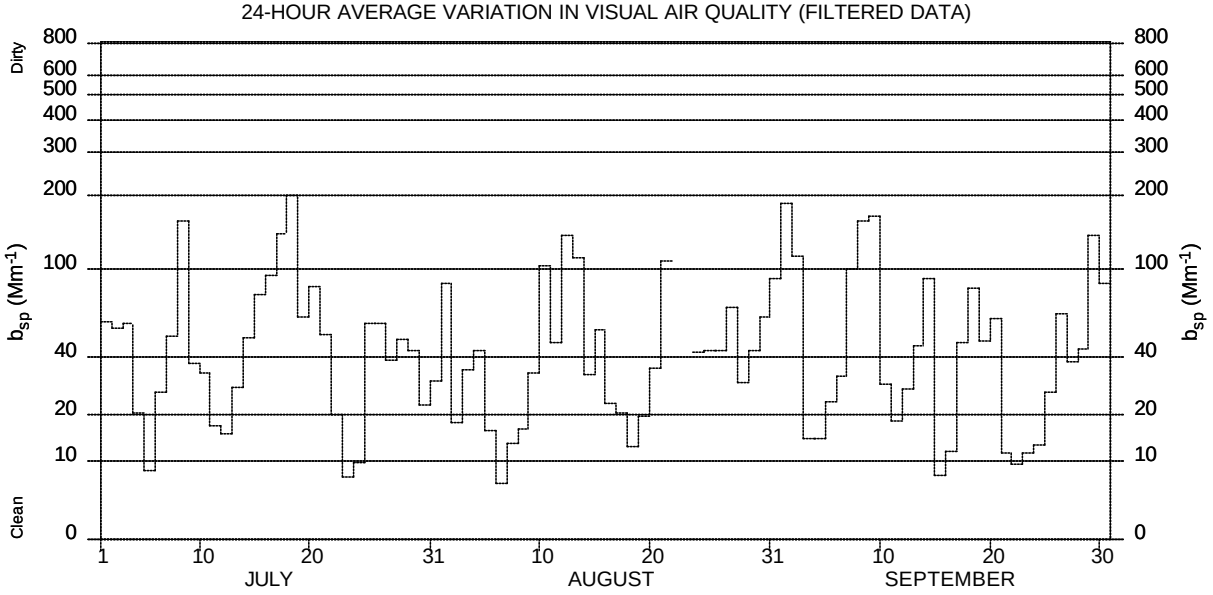
VISIBILITY METRIC (FILTERED DATA)

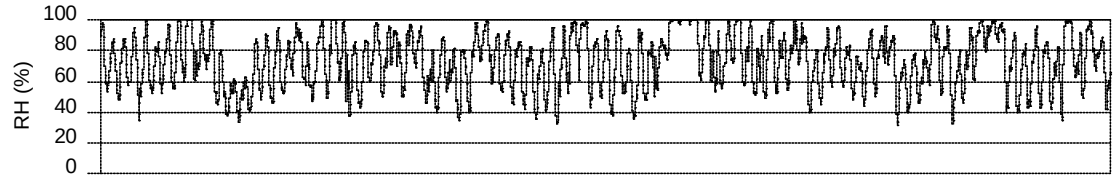
	b_{sp}
Mean of cleanest 20%	9.1
Mean of all data	49.0
Mean of dirtiest 20%	127.7

NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2208	100
Valid Hourly Averages (Filtered and Unfiltered)	2198	100
Valid Hourly Averages (Filtered)	1493	68
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		68

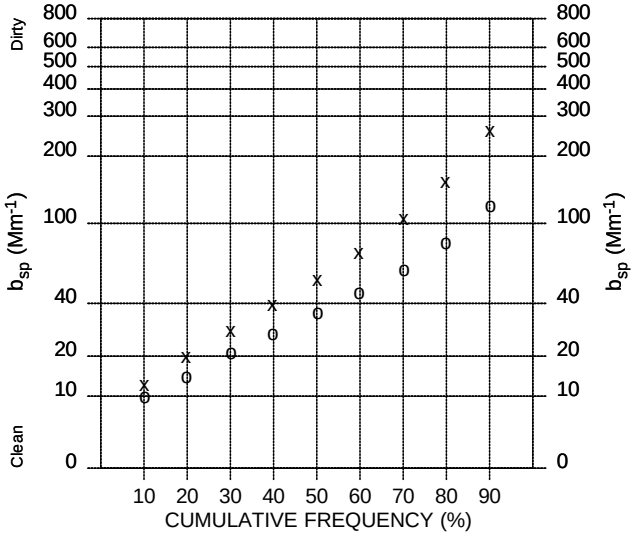
MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Third Quarter: July 1, 2002 - September 31, 2002

24-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)





FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	11.0	9.0
20	18.0	13.0
30	26.0	19.0
40	36.0	25.0
50	49.0	33.0
60	68.0	42.0
70	97.0	55.0
80	145.0	75.0
90	244.0	112.0

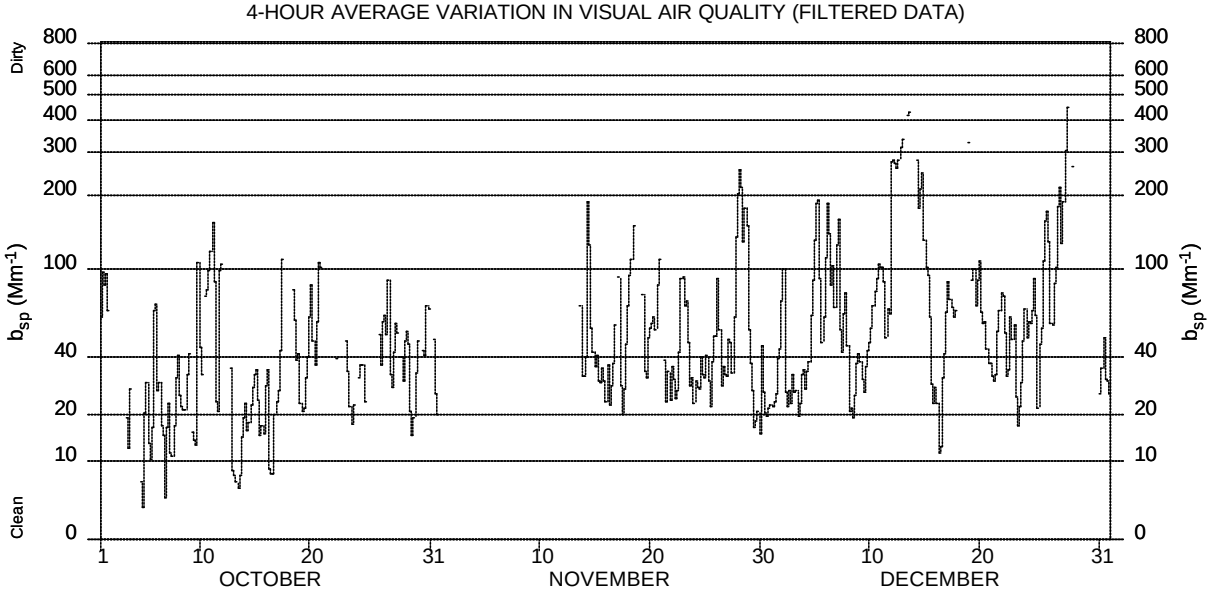
VISIBILITY METRIC (FILTERED DATA)

	b_{sp}
Mean of cleanest 20%	9.1
Mean of all data	49.0
Mean of dirtiest 20%	127.7

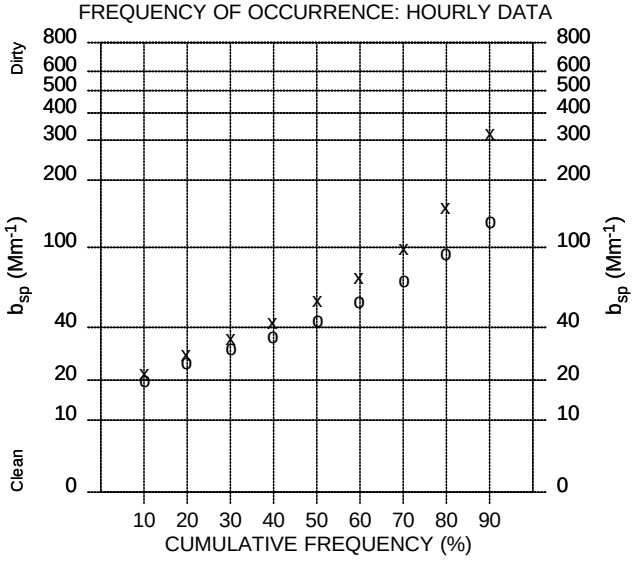
NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2208	100
Valid Hourly Averages (Filtered and Unfiltered)	2198	100
Valid Hourly Averages (Filtered)	1493	68
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		68

MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Fourth Quarter: October 1, 2002 - December 31, 2002

4-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)



FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	20.0	18.0
20	26.0	23.0
30	32.0	28.0
40	39.0	33.0
50	51.0	40.0
60	66.0	50.0
70	91.0	64.0
80	141.0	86.0
90	301.0	121.0

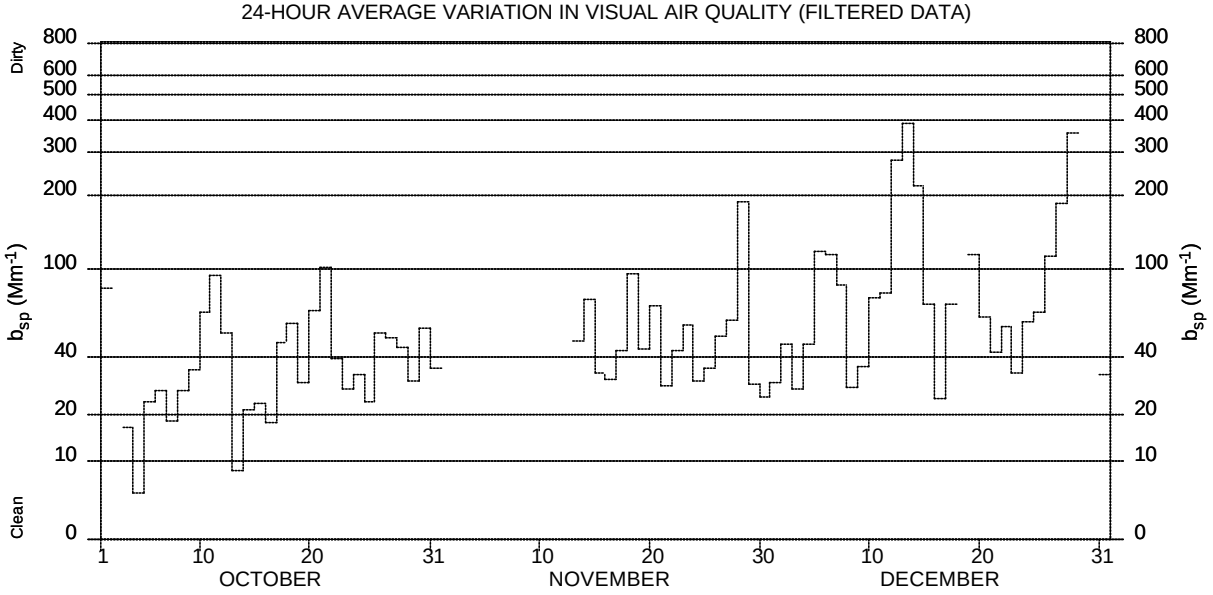
VISIBILITY METRIC (FILTERED DATA)

	b_{sp}
Mean of cleanest 20%	16.4
Mean of all data	61.3
Mean of dirtiest 20%	156.1

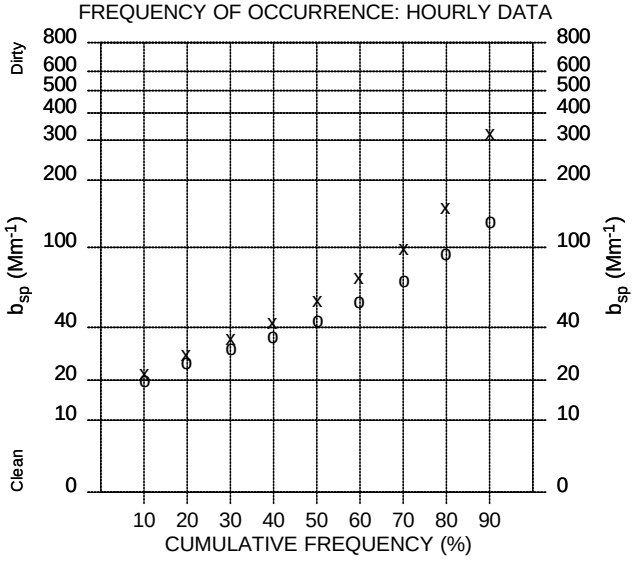
NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2208	100
Valid Hourly Averages (Filtered and Unfiltered)	1860	84
Valid Hourly Averages (Filtered)	1432	65
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		77

MAYVILLE, WISCONSIN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Fourth Quarter: October 1, 2002 - December 31, 2002

24-HOUR AVERAGE VARIATION IN VISUAL AIR QUALITY (FILTERED DATA)



FREQUENCY OF OCCURRENCE: HOURLY DATA



CUMULATIVE FREQUENCY SUMMARY

%	Unfiltered Data [x] b_{sp}	Filtered Data [o] b_{sp}
10	20.0	18.0
20	26.0	23.0
30	32.0	28.0
40	39.0	33.0
50	51.0	40.0
60	66.0	50.0
70	91.0	64.0
80	141.0	86.0
90	301.0	121.0

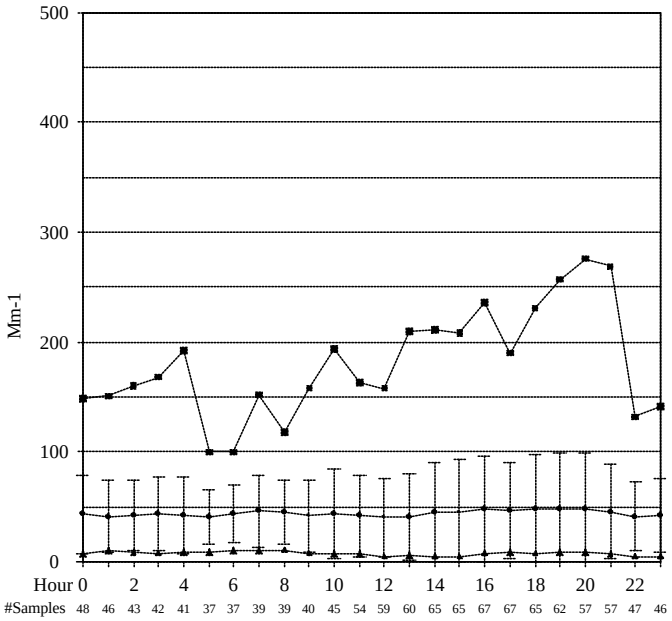
VISIBILITY METRIC (FILTERED DATA)

	b_{sp}
Mean of cleanest 20%	16.4
Mean of all data	61.3
Mean of dirtiest 20%	156.1

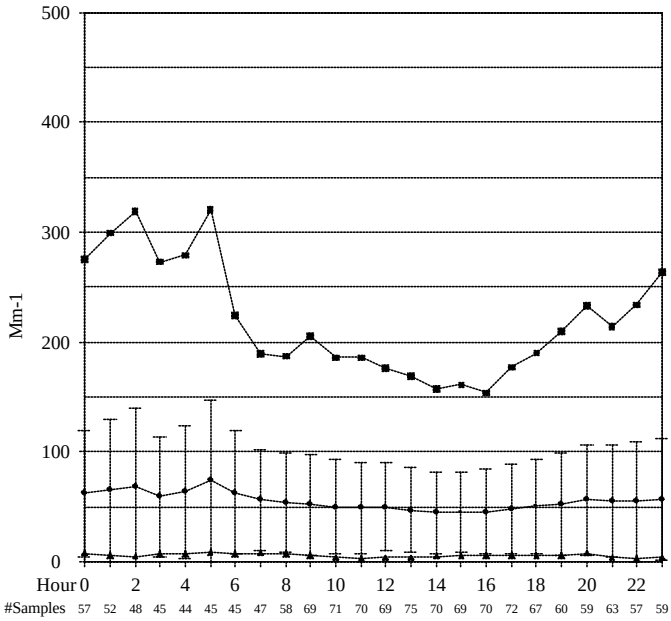
NEPHELOMETER DATA RECOVERY	NUM	%
Total Possible Hourly Averages In The Time Period	2208	100
Valid Hourly Averages (Filtered and Unfiltered)	1860	84
Valid Hourly Averages (Filtered)	1432	65
Filtered Data Percent Of Filtered and Unfiltered Hourly Averages		77

Light Scattering (Bsp) Plots

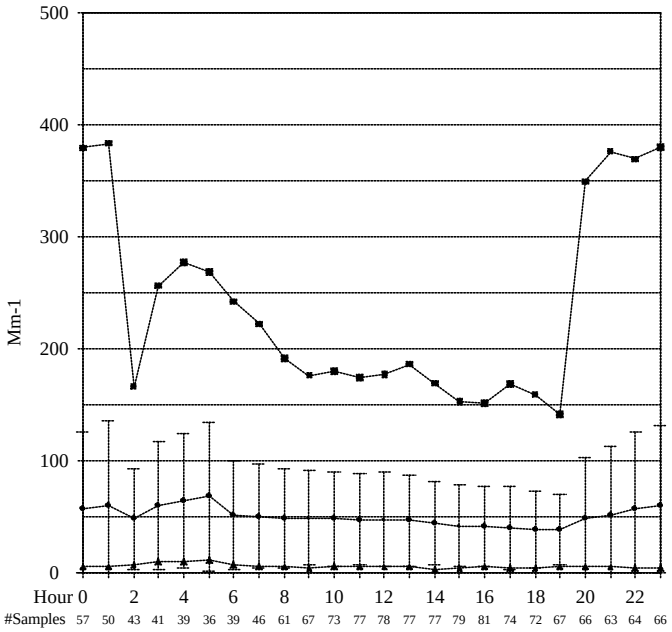
FIRST QUARTER (JAN-MAR)



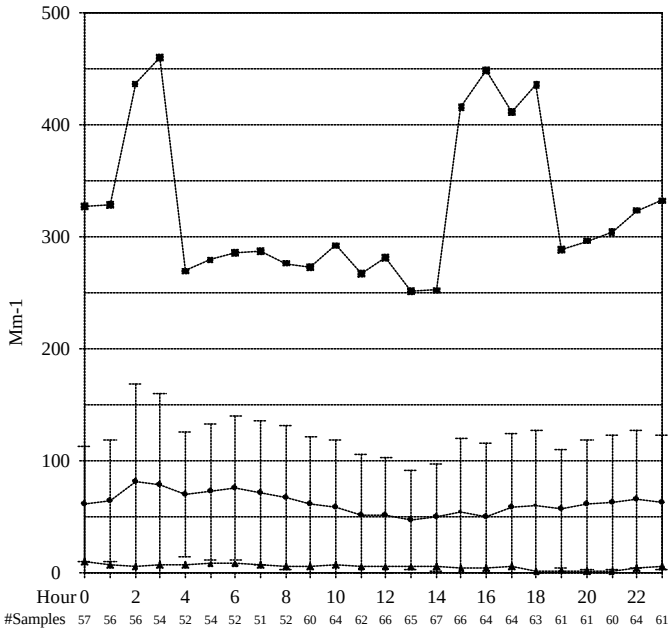
SECOND QUARTER (APR-JUN)

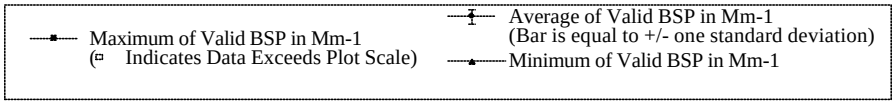


THIRD QUARTER (JUL-SEP)



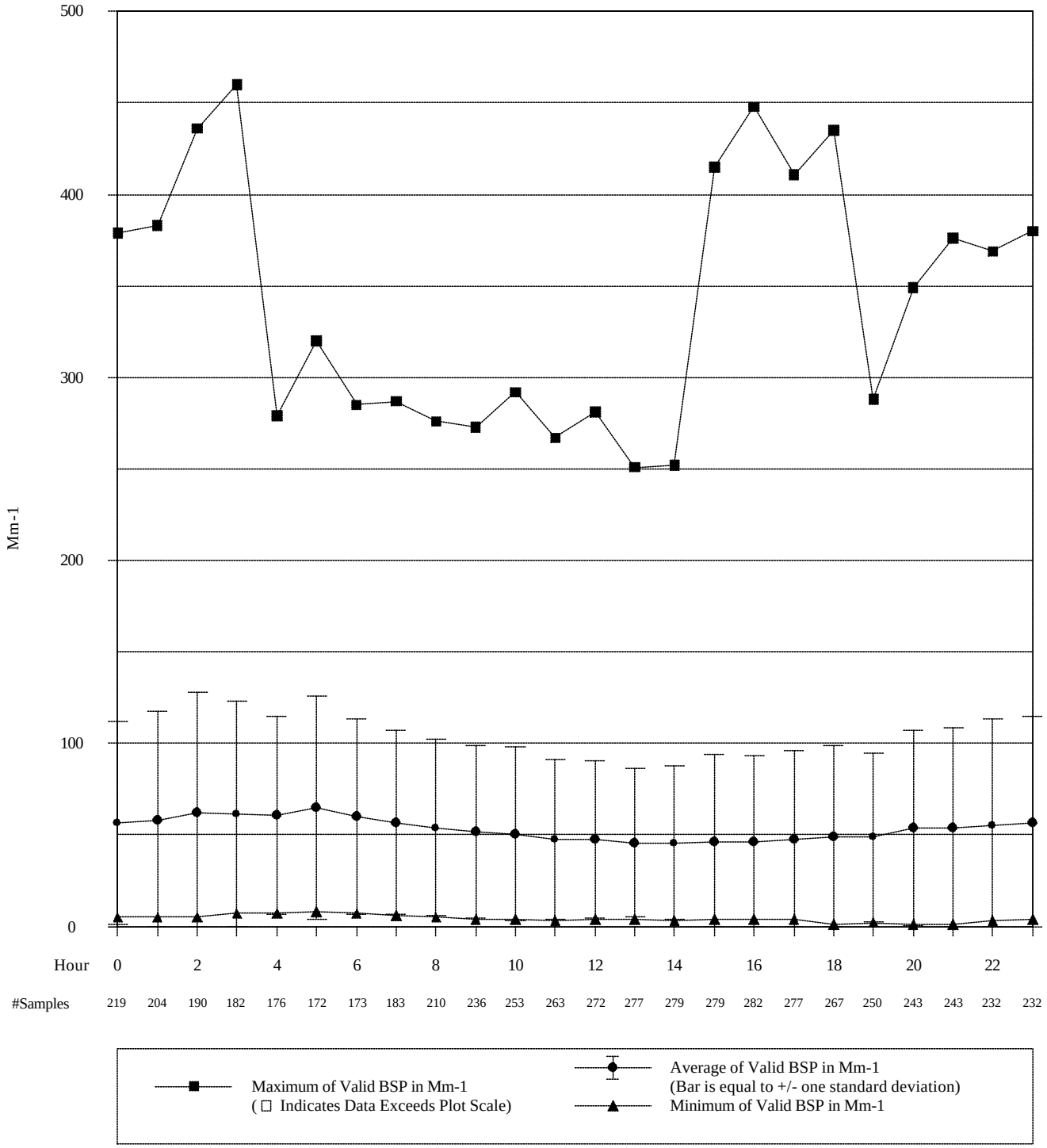
FOURTH QUARTER (OCT-DEC)





Mayville Visibility Study Annual Diurnal 2002

Light Scattering (Bsp) Plot



Final Validation 06-13-2003

APPENDIX F

NEPHELOMETER OPERATIONAL TIMELINES

Mayville Nephelometer
Operational Timeline

December 1, 2001 - March 31, 2002

Date	Summary
12/07/01	Nephelometer SN 044 in operation. Site visit. Nephelometer calibrated (Z=31.5; S=107.6). AT/RH sensor audited (NIST Standard).
12/29/01	Site visit. Nephelometer calibrated (Z=33.2; S=114.3). AT/RH sensor audited (NIST Standard).
01/10/02	Site visit. Nephelometer calibrated (Z=35.5; S=109.7). AT/RH sensor audited.
02/01/02	Site visit. AT/RH sensor audited.
02/03/02	Site visit. Lamp replaced (out 2/1 – 2/3).
02/13/02	Site visit. AT/RH sensor audited.
02/26/02	Site visit. Nephelometer calibrated (Z=37.2; S=114.8). AT/RH sensor audited.
03/11/02	Site visit. Nephelometer calibrated (Z=37.6; S=111.4). AT/RH sensor audited.
03/18/02	Site visit. Nephelometer calibrated (Z=38.8; S=99.7).
03/19/02	Site visit. AT/RH sensor audited.
03/27/02	Site visit. Multipoint audit performed on AT/RH sensor with NIST Standard.

Mayville RH Audit Results
Using NIST Standard

Date	Time	DNR Logger RH%	ARS Logger RH%	NIST Expected
03/27/02	13:40	92.5	92.5	80.1
	14:10	100.0	101.4	95.0
	15:10	53.8	53.7	50.1
	16:15	50.2	50.2	50.2
	17:15	81.2	81.2	80.1
04/10/02	12:43	89.2	89.2	80.0

Mayville Nephelometer
Operational Timeline

April 1, 2002 – June 30, 2002

Date	Summary
04/07/02	Nephelometer SN 044 in operation. Site visit. Nephelometer calibrated (Z=41.2; S=112.7).
04/10/02	Site visit. AT/RH sensor replaced. AT/RH sensor audited (NIST Standard). AT/RH offline for installation and audit from 1015 through 1600. It is suspected that the AT/RH sensor has been malfunctioning since mid-March. When audited with an 80% NIST standard, the station RH reading was found to be higher than expected.
04/22/02	Site visit. Nephelometer calibrated (Z=42.1; S=114.6). The connector on the AT/RH sensor cable shorted out due to moisture (data invalidated 4/21 (2105) through 4/22 (1020). Wind speed, wind direction and standard deviation of wind direction were malfunctioning during this same time period.
04/25/02	Site visit. AT/RH sensor audited (NIST Standard). AT/RH offline for audit from 0900 through 1225.
05/03/02	Site visit. Nephelometer calibrated (Z=42.1; S=114.8). Lamp replaced.
05/07/02	Site visit. AT/RH sensor audited (NIST Standard). AT/RH offline for audit from 0950 through 1610.
05/22/02	Site visit. Nephelometer calibrated (Z=43.6; S=112.5).
06/20/02	Site visit. Nephelometer calibrated (Z=43.7; S=107.9).

Mayville Nephelometer
Operational Timeline

July 1, 2002 – September 30, 2002

Date	Summary
07/09/02	Nephelometer SN 044 in operation. Site visit. Nephelometer calibrated (Z=45.1; S=108.0).
07/23/02	Site visit. AT/RH sensor replaced. AT/RH sensor audited (NIST Standard). AT/RH offline for installation and audit from 0940 through 1555. Nephelometer calibrated (Z=47.9; S=118.0). Lamp replaced.
07/30/02	Wisconsin DNR personnel on site for yearly meteorological audit. Wind speed and wind direction equipment offline 0900 through 1200.
08/20/02	Site visit. Nephelometer calibrated (Z=51.8; S=120.6). AT/RH offline for audit from 1000 through 1310.
09/19/02	Site visit. Nephelometer calibrated (Z=54.3; S=120.2).

Mayville Nephelometer
Operational Timeline

October 1, 2002 – December 31, 2002

Date	Summary
10/14/02	Nephelometer SN 044 in operation. Site visit. Nephelometer calibrated twice (Z=59.1; S=128.8 and Z=58.3; S=129.2).
10/24/02	Site visit. Nephelometer calibrated (Z=55.9; S=133.0). AT/RH sensor audited (NIST Standard). AT/RH offline for audit from 1000 through 1455.
10/31/02	Site visit. Nephelometer calibrated (Z=61.6; S=136.6). Nephelometer and AT/RH sensor removed for annual service.
11/13/02	Site visit. Nephelometer and AT/RH sensor reinstalled. Nephelometer calibrated three times (Z=99.0; S=183.6, Z=100.1; S=185.1, and Z=100.7; S=184.5).
11/19/02	Site visit. Nephelometer calibrated (Z=108.1; S=193.8).
12/03/02	Site visit. Nephelometer calibrated (Z=122.7; S=217.4).
12/18/02	Site visit. Nephelometer calibrated (Z=123.1; S=200.6).

APPENDIX G

$PM_{2.5}$ SUMMARY DATA PRODUCTS

PM2.5 TEOM

10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

Final Validation
01/01/2002 - 03/31/2002

Value	Date	Hour	Concentration (ug/m3 lc)
PM2.5 TEOM			
1	01/06/2002	16	24.8
2	03/28/2002	22	23.9
3	03/29/2002	0	20.7
4	03/05/2002	9	19.4
5	03/08/2002	2	18.5
6	03/19/2002	17	17.5
7	03/18/2002	20	17.1
8	03/02/2002	22	16.2
9	03/06/2002	0	16.0
10	03/12/2002	6	16.0**

** This value was also recorded on one or more days later in the reported period.

PM2.5 TEOM

10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

Final Validation
04/01/2002 - 06/30/2002

Value	Date	Hour	Concentration (ug/m3 lc)
PM2.5 TEOM			
1	06/23/2002	23	55.0
2	06/24/2002	5	50.5
3	06/09/2002	19	45.4
4	06/30/2002	19	43.0
5	06/25/2002	17	41.7
6	06/28/2002	16	41.4
7	05/28/2002	20	37.5
8	06/22/2002	22	34.5
9	06/21/2002	22	33.3
10	05/29/2002	3	32.2**

** This value was also recorded on one or more days later in the reported period.

PM2.5 TEOM

10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

Final Validation
07/01/2002 - 09/30/2002

Value	Date	Hour	Concentration (ug/m3 lc)
PM2.5 TEOM			
1	09/15/2002	4	58.8
2	07/09/2002	12	58.4
3	08/11/2002	17	57.3
4	09/01/2002	19	55.0
5	09/08/2002	22	50.4
6	07/18/2002	13	50.3
7	07/28/2002	19	49.4
8	09/07/2002	22	48.0
9	08/10/2002	20	46.1
10	08/30/2002	19	43.2

PM2.5 TEOM

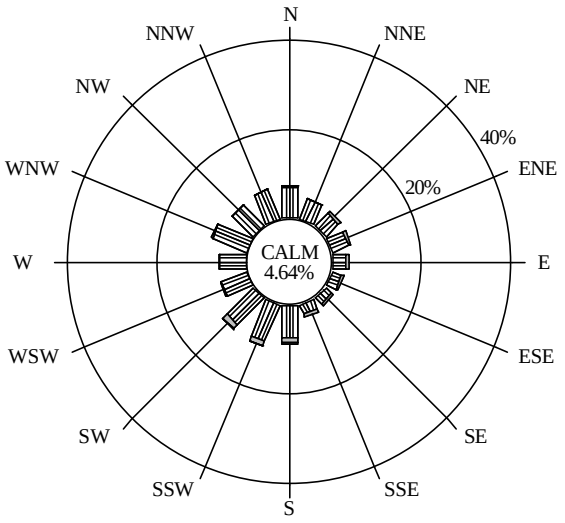
10 Highest Daily 1-Hour Average Maximum Concentrations
Mayville Visibility Study

Final Validation
10/01/2002 - 12/31/2002

Value	Date	Hour	Concentration (ug/m3 lc)
PM2.5 TEOM			
1	10/01/2002	0	49.1
2	11/08/2002	10	37.7
3	12/06/2002	8	37.1
4	10/12/2002	4	33.8
5	11/04/2002	18	32.8
6	10/11/2002	19	28.3
7	12/14/2002	17	22.3
8	10/10/2002	21	21.4
9	12/13/2002	16	21.0
10	11/10/2002	10	19.7

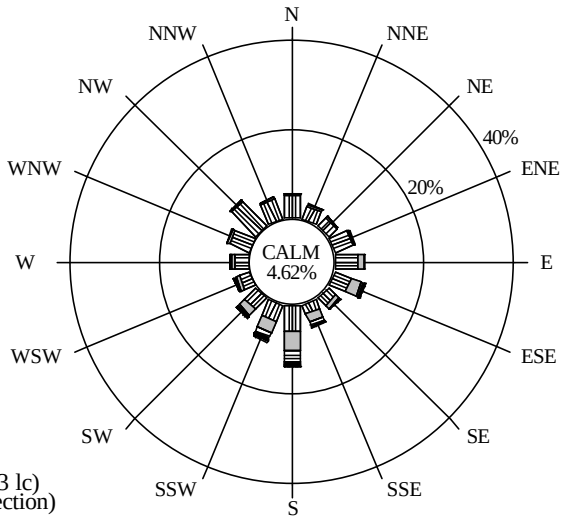
Mayville Visibility Study Quarterly PM2.5 TEOM 2002
Pollutant Rose

FIRST QUARTER (JAN-MAR)



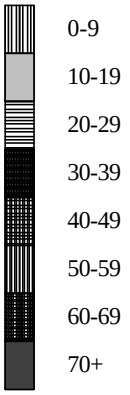
91.8% Collected 90.8% Valid
2160 Possible /1982 Collected /1961 Valid

SECOND QUARTER (APR-JUN)

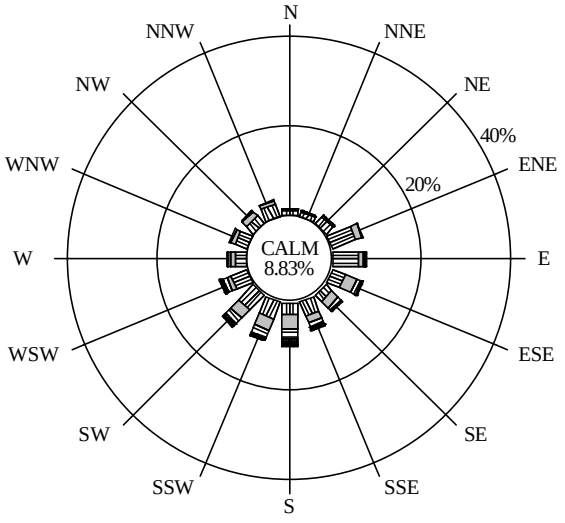


99.6% Collected 99.1% Valid
2183 Possible /2174 Collected /2163 Valid

PM2.5 TEOM (ug/m3 lc)
(vs Scalar Wind Direction)

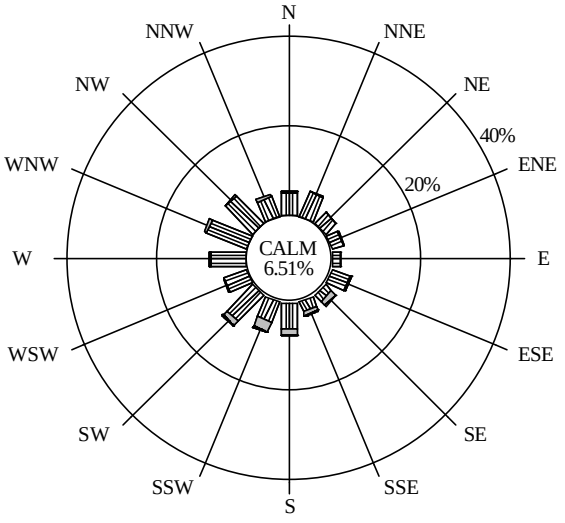


THIRD QUARTER (JUL-SEP)



98.2% Collected 80.0% Valid
2208 Possible /2169 Collected /1767 Valid

FOURTH QUARTER (OCT-DEC)

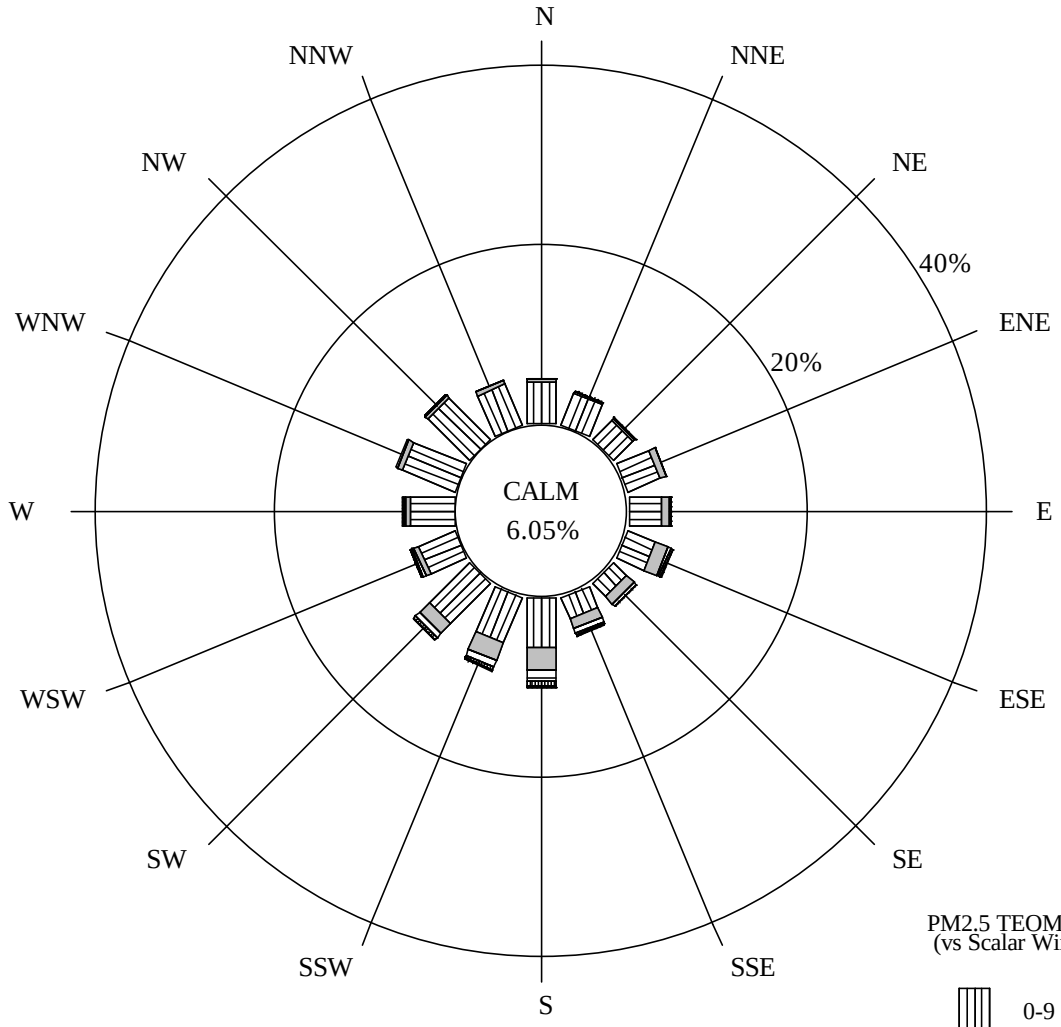


98.6% Collected 94.7% Valid
2208 Possible /2176 Collected /2090 Valid

Final Validation

07-16-2003

Pollutant Rose



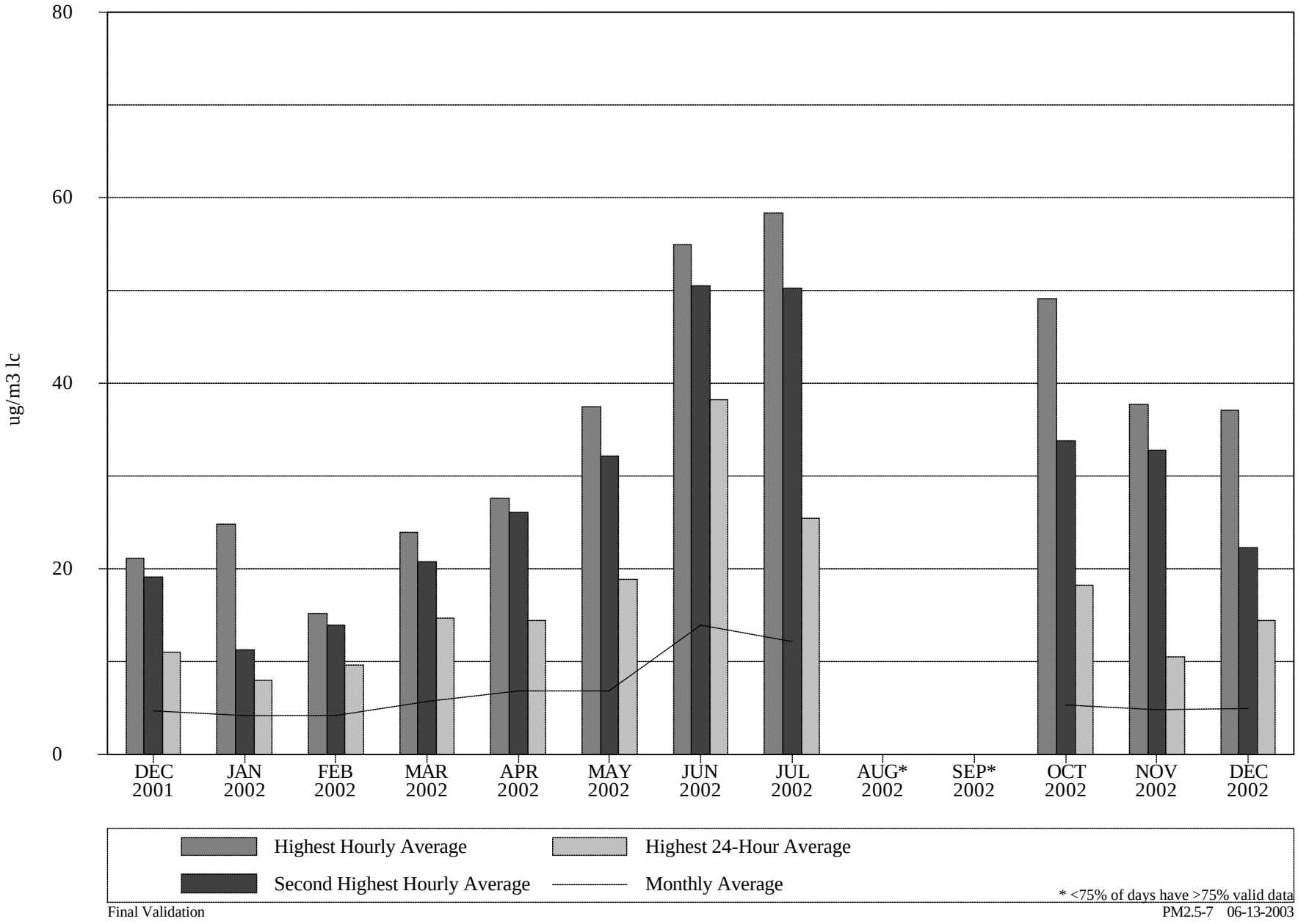
97.1% Collected 91.1% Valid

8759 Possible /8501 Collected /7981 Valid

Mayville Visibility Study

PM2.5 TEOM Data Summary by Month
December 2001 to December 2002

12/01/2001 - 12/31/2002

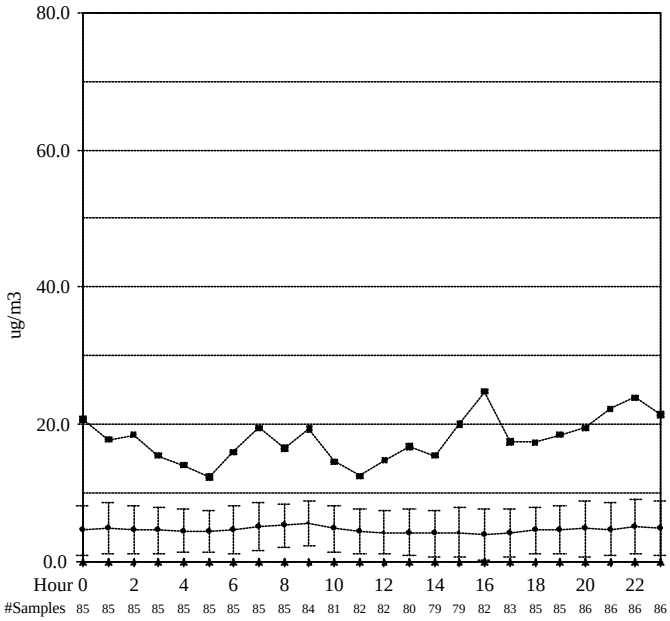


* <75% of days have >75% valid data

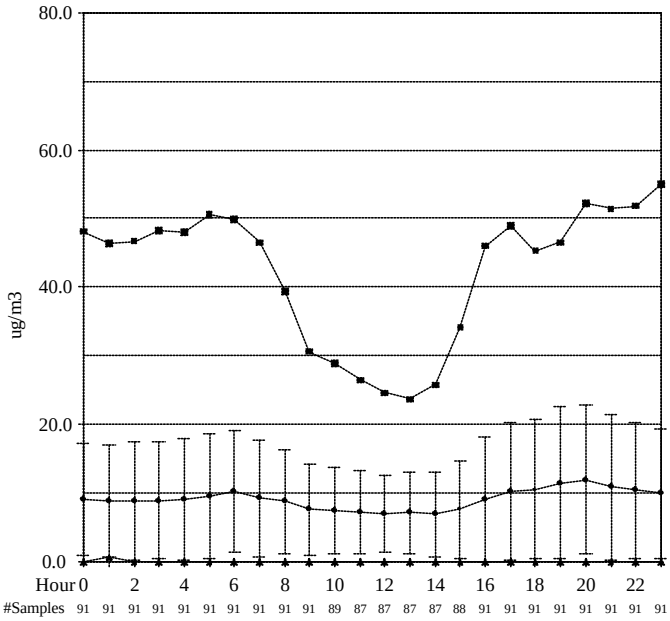
Final Validation

PM2.5-7 06-13-2003

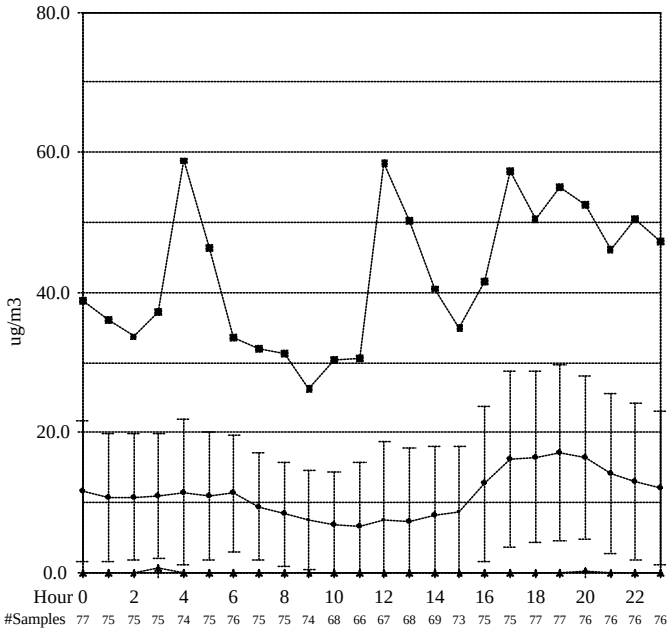
FIRST QUARTER (JAN-MAR)



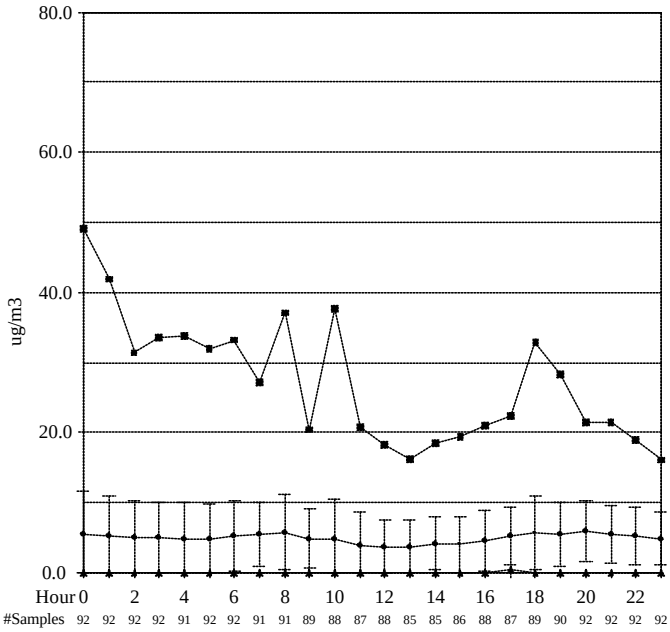
SECOND QUARTER (APR-JUN)

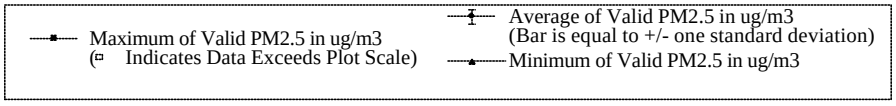


THIRD QUARTER (JUL-SEP)

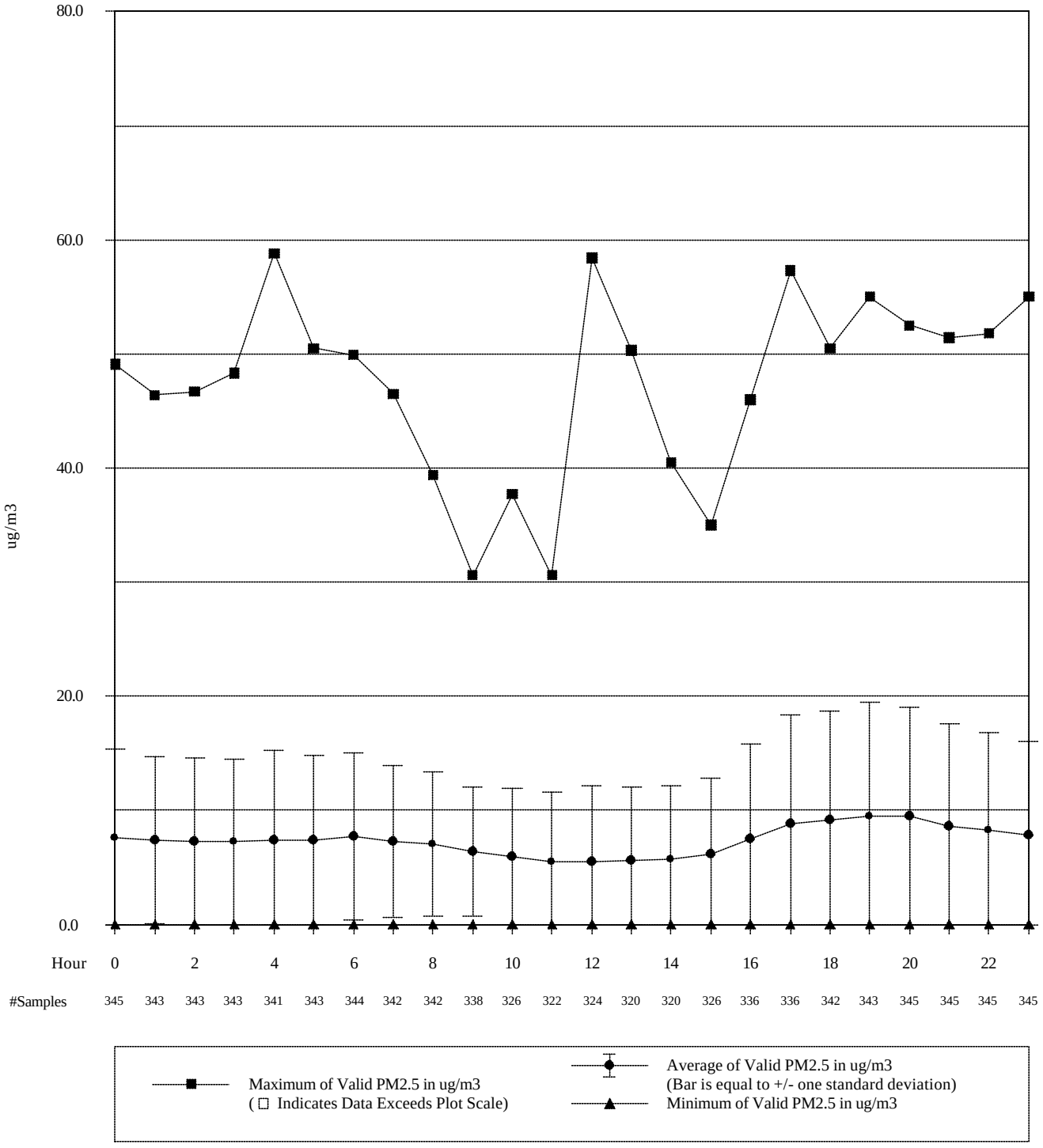


FOURTH QUARTER (OCT-DEC)





Mayville Visibility Study | Annual Diurnal PM2.5 Plot | 2002



Final Validation

06-13-2003